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REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN NSY PORTSMOUTH VA
3/1/1988
ENVIRONMENTAL STRATEGIES CORPORATION



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REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN
FOR THE
ATLANTIC WOOD INDUSTRIES, INC. SITE
IN
PORTSMOUTH, VIRGINIA

PREPARED
BY

ENVIRONMENTAL STRATEGIES CORPORATION

MARCH 1, 1988

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INTRODUCTION

Atlantic Wood Industries (AWI) intends to conduct a Remedial Investigation/Feasibility study (RI/FS) consistent with the requirements of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) at its Portsmouth facility. The RI/FS will be conducted in accordance with the National Oil and Hazardous Substances Contingency plan (NCP) 40 CFR 300 and the Administrative Order by Consent (ACO) entered into by AWI and EPA Region III on July 23, 1987. This Work Plan presents an overall approach to the RI/FS and the planned technical investigation.

1.0 ATLANTIC WOOD INDUSTRIES SITE BACKGROUND

1.A Site Background

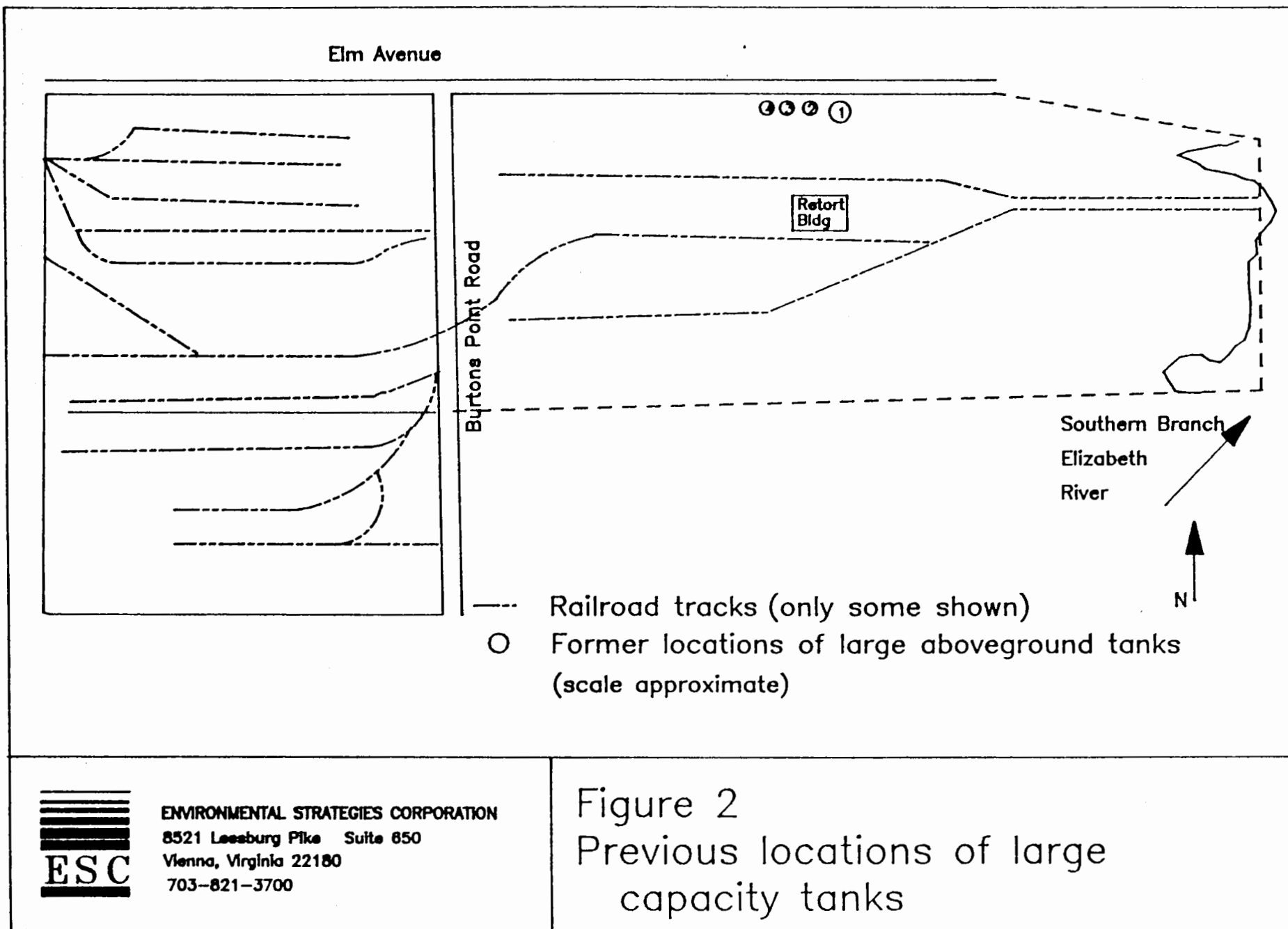
1.A.1 Site History

Atlantic Wood Industries, Inc. (AWI) owns an active wood treating facility located in Portsmouth, Virginia (Figure 1). AWI or a predecessor of AWI purchased the Portsmouth site in about 1926. Before 1926, the grounds were undeveloped except possibly for a saw mill. There may have been a marsh or swamp on the site. The existence of this area has not been confirmed, however. A review of maps showing the historic shoreline of the west bank of the South Branch of the Elizabeth River suggests

that at least a portion of the AWI site was elevated with fill. From 1926 until 1944, the site was operated as the Savannah Creosoting Company and owned by the Savannah Creosoting Company, Inc., a Maryland corporation. On December 28, 1944, the name of the corporation was changed to Atlantic Creosoting Company, Inc. On September 1, 1978, the name of the corporation was changed to Atlantic Wood Industries, Inc. Ownership of the corporation and the site has subsequently changed on several occasions as noted in the ACO. Since January 1, 1986, the site has been owned by Atlantic Wood Industries employees under an employee stock ownership plan.

The original Savannah Creosoting Company site is said to have consisted of two of the existing four wood treatment retorts, the existing office building, several existing maintenance and storage buildings, and the recently removed aboveground tank farm that was located adjacent to Elm Avenue. These tanks (designated as tanks 1 through 4, east to west) were steel and had open tops. Tank no. 1 held 880,000 gallons, while the others each held 440,000 gallons (Figure 2). All the tanks were originally used to store creosote. In the past, tanks no. 1 and 2 were used occasionally to store process water produced by wood treating operations. Although the tanks have been removed, valves and piping associated with the tanks still exist and can be easily used to visually reconstruct the locations of the tanks.

The existing tanks are summarized in Table 1 and depicted on Figure 3. The existing Tanks 1, 2, 3, and 4 (not to



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Figure 2
Previous locations of large
capacity tanks



Locations of existing tanks

Table 1

List of Storage Tanks

<u>Tank Designation</u>	<u>Capacity (gal.)</u>	<u>Contents or Use</u>
1	12,260	Boiler fuel
2	12,260	Boiler fuel
3 (not in use)	12,260	Liquidator feed tank
4 (not in use)	12,260	Liquidator feed tank
5	62,568	Dehydrating tank
9	62,568	Dehydrating tank (not in use)
D	128,968	Creosote storage (currently empty)
4-Pen (not in use)	27,648	Pentachlorophenol concentrate storage
P1 and P2 (not in use)	79,900	PCP working solution
Retort I ²	56,400	Creosote treatment
Retort II ²	56,400	Creosote treatment
Retort III ²	48,900	Creosote treatment
Retort IV ²	56,400	PCP treatment (not in use)
A	81,216	Creosote storage
B	81,216	Creosote storage
C	66,960	Creosote storage
Yard fuel	10,200	Diesel fuel
Truck fuel	8,060	Diesel fuel
Fuel oil tank ¹	550	No. 2 Fuel oil

1/ The fuel oil tank was the only underground tank on site and was removed about five years ago.

2/ These are horizontal process vessels (pressure retorts) and not storage tanks.

be confused with the removed storage tanks) were previously associated with a tar distillation unit that was located east of the office building (Figure 2). There was also a shallow concrete basin associated with the tar distillation unit. The tar distillation unit was dissembled in the 1940s. The basin was filled in and the four tanks were moved to their present location west of the retorts. Portions of the retaining wall around the basin are currently exposed and can be examined. In addition, from about 1940 until October 1985, there was a concrete process water recycle basin located immediately north of the retort building (Figure 2). This unit was used to recover preservative from process water and until 1972, some excess process water was discharged to an area immediately south of the railroad spur that juts out into the South Branch of the Elizabeth River. AWI continued to use the unit to recover preservative and to recycle process water until it was removed in August 1985.

Retorts I and II were original wood treatment units at the site. Retorts III and IV were added in 1960 and 1974. Pentachlorophenol was first used at the site in about 1972 in Retort I. The plant operator used Retort I at times for pentachlorophenol and at other times for creosote treatment for about two years. In 1974, Retort IV was constructed and was dedicated to pentachlorophenol treatment operations.

Site operators also used a pentachlorophenol related product since the late 1950s. This material, known as creo-penta was stored in a tank near the now removed oil/water separator.

Site operators stopped using creo-penta in the early to mid 1960s.

Until the early 1970s, operations included an open steaming process (the introduction of live steam into the retort to heat and condition the wood), which generated excess amounts of process water. Closed steaming (generating steam in the retort by means of steam heating coils covered with water) was instituted in the early 1970s to reduce the amount of process water handled.

In 1974 when Retort IV was constructed for pentachlorophenol, a closed-loop recovery system was installed to recover pentachlorophenol and process conditioning water for reuse. This operation ceased in 1985 when the use of this preservative was discontinued.

Until about 1985, the plant used a concrete closed-loop recovery system located just north of the retort building. This unit was used to recover creosote preservative and process conditioning water for reuse. This system was removed in 1985 but the process is now handled by a closed-loop recovery system located in the retort building.

When the Clean Water Act was implemented in the early 1970s, the plant was required to stop discharging effluent from the oil/water separator. At that time, a liquid incineration unit known as a "Liquidator" was constructed. This unit was fired with No. 6 fuel oil and incinerated process water that was previously discharged through the oil/water separator into the river. AWI stopped using the Liquidator unit in 1984.

Current Processing Operations

Current operations at the plant involve a multi-stage conditioning, pressure treatment, and pressure equilization process. After the retort is charged with peeled poles or lumber, approximately 4,000 gallons of recycled processed water are added to the retort to cover the closed steam heating coils. The heating coils boil the water, during which time the wood is heated and conditioned. After conditioning is complete, a vacuum is pulled on the retort to remove water from the wood cells. The water is removed from the retort and sent to the closed-loop process recovery system. The retort is then filled with preservative from one of the work tanks (A, B, or C) and pressurized to achieve the proper penetration of preservative into the wood cells. The unused preservative is returned to the proper work tank and a vacuum is applied to the retort to remove the excess preservative from the wood cells and retort. The pressure is then equalized to atmospheric pressure and the wood remains in the retort to allow any excess drippage to be collected in the retort before the charge is withdrawn. The process takes about 20-24 hours to complete one treatment cycle.

The closed-loop process recovery system is used to recover preservative from the conditioning process water before reuse of this water. Occasionally the recovered preservative is processed in tank No. 5 (dehydrator) to remove excess moisture content.

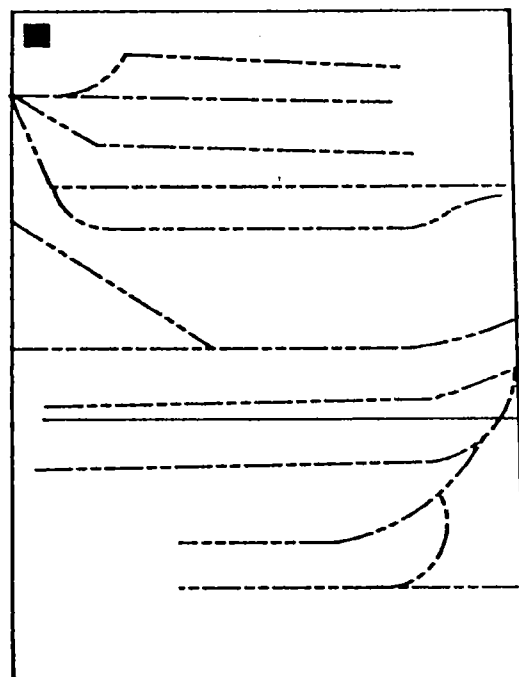
The plant currently treats with one preservative, creosote. The use of pentachlorophenol was discontinued in late 1985.

Past Waste Handling Operations

Preliminary to the preparation of this RI/FS work plan, records have been reviewed and employees and ex-employees were consulted. It appears that a variety of solid, liquid and semi-solid wastes were generated in the past. These were disposed of on-site, discharged or hauled off-site. Currently, all process residuals are either recycled or sent off-site to licensed waste handling facilities. There are three outfalls (001, 002, and 003) associated with stormwater runoff only (Figure 4). Outfall 001 accepts flows directed eastward from a divide located in the vicinity of Burtons Point Road. Outfall 001 flows into the Elizabeth River at the southern terminus of the AWI property. It should be noted that the Navy discharged wastes related to the production of acetylene in the ditch associated with the outfall. There are currently extensive piles of white material resembling partially set concrete along the 001 ditch. There is a divide located north of 001, which directs runoff northward to outfall 002. Outfall 002 discharges into the Elizabeth River. Outfall 002 accepts flows from land surfaces located north of Elm Avenue and plant areas located west of the office building. Outfall 003 discharges stormwater runoff from a large storage area located west of Burtons Point Road and South of Elm Avenue. This outfall discharges into an open ditch which flows north and eventually empties into Paradise Creek.

003

Elm Avenue




Burtons Point Road

③③②①

Refort
Bldg

002

001

 Southern Branch
Elizabeth
River
 


- Locations of NPDES outfalls
- Railroad tracks (only some shown)
- Former locations of large aboveground tanks
(scale approximate)



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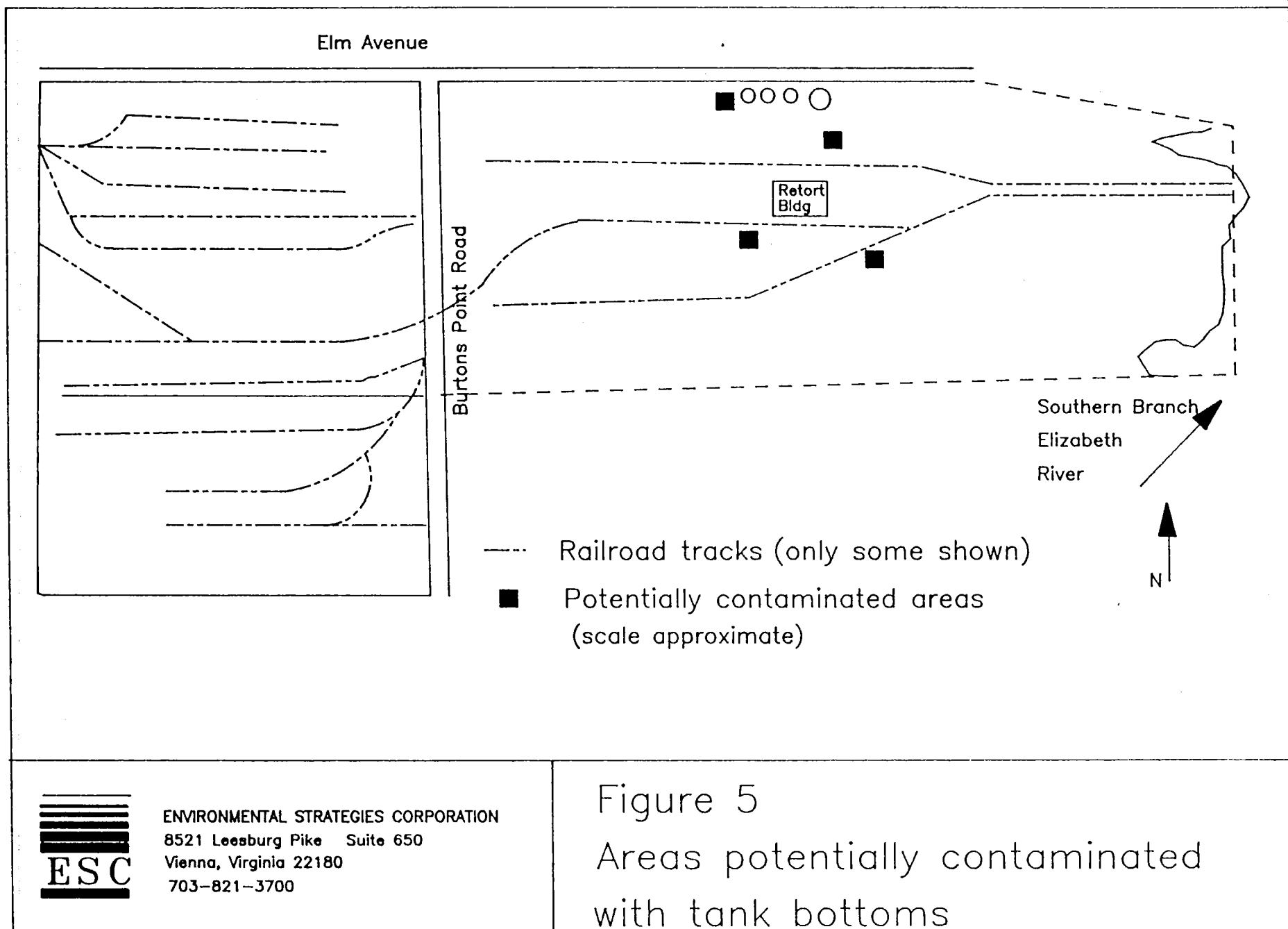
Figure 4
 NPDES Outfalls – 001, 002, & 003

These outfalls only discharge stormwater runoff. Nevertheless, these drainage features, especially outfall 002, are located adjacent to the treatment retorts and the process water holding tanks. Because of this potential for surface water contamination, these areas are addressed in the sampling plan contained in this work plan.

In addition to outfall 002, there is a City of Portsmouth storm sewer which may have been infiltrated by wood treatment chemicals from the now removed, large storage tanks 1, 2, 3 and 4 or other sources. This storm sewer also discharges to the Elizabeth River and may be a significant off-site contamination source. As a result of an earlier investigation into potential sources of contamination, the tanks were found to be leaking and were removed. There are other contamination sources on-site, however.

Some employees have suggested that before the 1950s, tank bottoms may have been deposited in proximity to the source tank. The area east of tank 9 was recalled by employees interviewed as being a low lying area that was sometimes wet (Figure 5). There is some potential that other areas like this on site, particularly in the vicinity of the tank farms, may have been contaminated with tank bottoms. Therefore, these areas will be investigated in the sampling plan.

Some employees have suggested that from the 1950s to the 1960s, area west of the removed tank no. 4 and southwest of the retort building possibly may have been contaminated with tank bottoms (Figure 5).



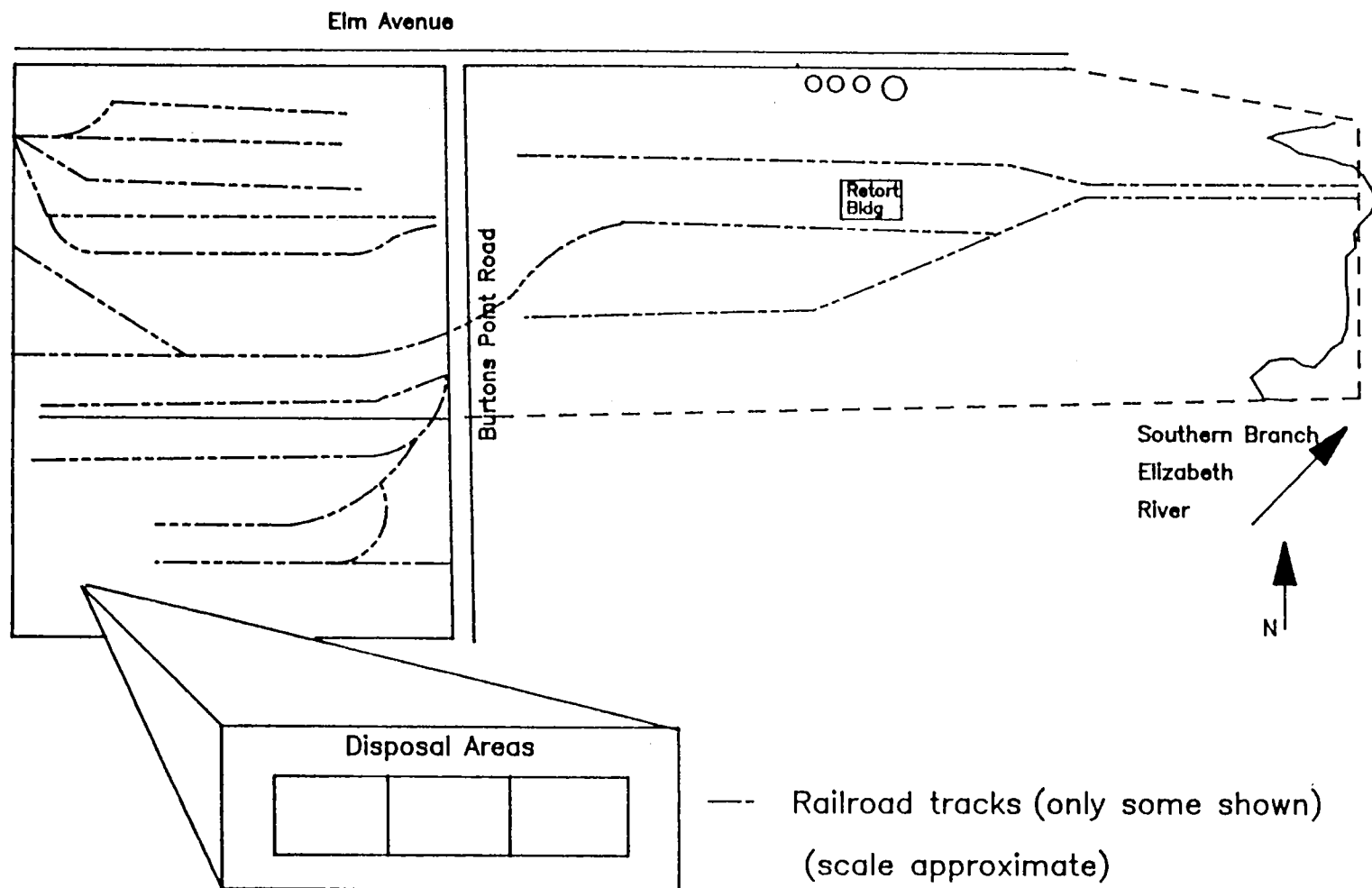
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Figure 5
Areas potentially contaminated
with tank bottoms

From approximately 1970 to 1979, tank bottoms and various other assorted residuals were reportedly deposited at the southwest corner of the AWI property in three separate but contiguous areas (Figure 6). The westernmost area is thought to have received creosote related materials. The easternmost area, which was supposedly the largest area, is thought to have received pentachlorophenol related products. Treated wood, untreated wood, and steel bands were deposited in each of the areas. There was also a disposal area in the northwest corner of the site near the current refuse loading conveyor for the recycling plant, which was reportedly used for the disposal of "trash" (Figure 7).

The operations associated with the Liquidator were previously described. Reportedly 1 to 3 buckets of ash were removed from the Liquidator unit at least every 16 to 20 hours. The ash was disposed of in dumpsters and hauled off-site or was used on occasion as fill material around the plant. The locations where the material was spread around the plant are not identifiable.

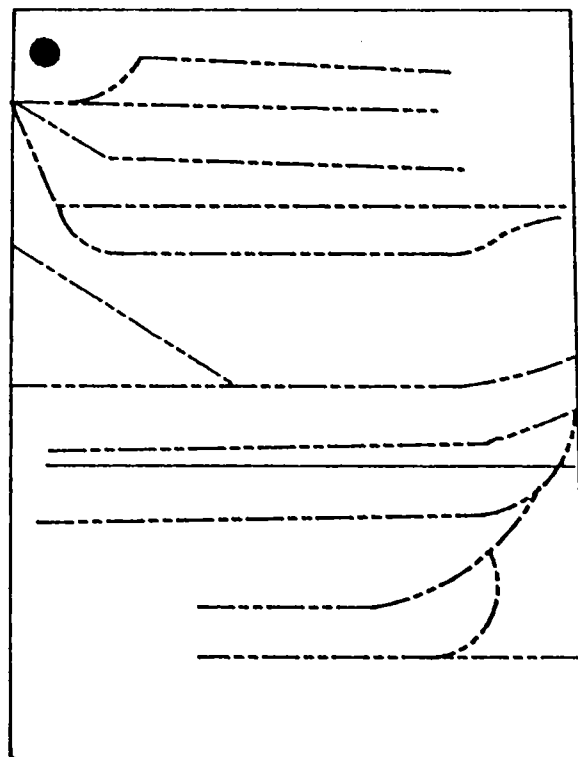
Excess process water from the concrete oil/water separator used to recover preservative was discharged to an area south of the loading dock. Site operations also included the use of a barometric condensor that was cooled by routing flows from the Southern Branch of the Elizabeth River to the condensor on a "once through" basis. The barometric condensor effluent water was discharged to the Elizabeth River at a point just north of the loading dock.



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Figure 6
Historic disposal areas

Elm Avenue



Burtens Point Road

○○○○

Retort
Bldg

Southern Branch
Elizabeth
River

- Railroad tracks (only some shown)
- Trash disposal area
(scale approximate)



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Figure 7
Trash Disposal Area

Several site investigations have been conducted by AWI, the Virginia Water Control Board (VWCB), and the EPA or its contractors at the AWI site. The data from these investigations are discussed in subsequent sections of this plan.

The data collected from these previous investigations have been used to plan for subsequent investigations under the RI/FS. Nearly all of the data are questionable from a QA/QC standpoint and thus will not be relied on in the analysis and evaluation of remedial action alternatives. The data have been used in a limited fashion to identify potentially contaminated source areas and to propose the initial investigations necessary to more accurately characterize these areas.

1.A.2 Site Location

The AWI facility currently occupies 47.5 acres of land in Portsmouth, Virginia. The site is bounded on the north by Elm Avenue and the Norfolk Naval Shipyard facilities and on the west by a Virginia Electric Power Company right-of-way. To the south of the site is the south annex of the Norfolk Naval Shipyard and the Portsmouth City School Board. AWI is bounded on the east by the South Branch of the Elizabeth River. The site is split into eastern and western portions by the Norfolk and Portsmouth Beltline R.R. and Burtons Point Road. The eastern portion of the site contains the active wood processing facilities and wood storage areas. The western portion of the site is used for the storage of treated and untreated wood.

West of the site, beyond the power company right-of-way, is a defunct trash incinerator and a US Navy operated drum storage yard. The Navy also operates a disposal area south of the property owned by the Portsmouth City School Board. The Norfolk Veneer Mill is located immediately north across Elm Avenue from the eastern portion of the AWI facility. Although no wood treatment is currently performed at the site, a past owner, Wyckoff, may have performed pressure treating of wood. In addition, there are or were at least three facilities located upstream from AWI on the Elizabeth River (Figure 1), Eppinger and Russell, Republic Creosoting, and Bernuth Lembcke, which handled many of the same wood treatment chemicals that have been used by AWI. Wood treating operations were performed at the first two facilities (which are currently inactive) and the third facility is an active terminal used for the handling of creosote. Eppinger and Russell stopped treating wood in about 1980. Republic Creosoting stopped treating wood in December 1971.

1.A.3 Physiography

The AWI site is in a relatively flat lying area with elevations ranging from mean sea level (MSL) to about 15 feet above MSL. Surface water drainage in the vicinity of AWI is via the facility's three outfalls 001, 002, and 003 and the Elm Avenue storm sewer which is the subject of the Phase I Removal Action for the AWI site. Surface water runoff from the northeast portion of the site and from offsite areas drains to the South Branch of the Elizabeth River via the storm sewer and outfall

002. Outfall 001 accepts flow directed eastward from a divide located in the vicinity of Burtons Point Road. Outfall 002 flows into the Elizabeth River at the southeastern terminus of the AWI property. Outfall 003 discharges stormwater runoff from the western portion of the site. This outfall discharges into an open ditch which flows north and eventually discharges into Paradise Creek.

1.A.4 Surface Water Hydrology

The Elizabeth River System is a tidal basin comprised of the Western, Southern, and Eastern Branches. The Lafayette River converges with the three branches to form a main stem, which empties into Hampton Roads. The Southern Branch is connected, via the Dismal Swamp Canal, to the Intercoastal Waterway which leads to Albermarle Sound and flows south to north in the vicinity of AWI. The Virginia Cut connects the Southern Branch to the Intercoastal Waterway which leads to Pamlico Sound.

The Elizabeth River has a drainage area of approximately 300 square miles (777 square km). Located within the intensively urbanized basin are portions of Norfolk, Portsmouth, Chesapeake and Virginia Beach. Approximately 0.5 million people reside in the drainage basin. There is very little topographic relief in the basin and freshwater inflow into the system is minimal, composed principally of drainage from the Dismal Swamp and stormwater runoff. The Elizabeth River is dominated by tidal effects, thus the flushing or mixing of pollutants is not as rapid as that typically associated with a flowing riverine system.

As of September 1983, there were approximately 48 industrial and 15 domestic permitted discharges received by the Elizabeth River. In addition, there are significant non point source runoff loadings from the heavily urbanized and industrialized drainage basin.

1.A.5 Hydrogeology

1.A.5.1 Regional Conditions

The area is underlain by about 2,000 to 4,000 feet of unconsolidated sedimentary strata, mostly gravel, sand, and clay, ranging in age from Cretaceous to Holocene, and overlying consolidated bedrock. The strata dip gently and thicken to the east.

There are four aquifers or systems of aquifers (Table 2): 1) the Columbia Aquifer, 2) the Yorktown-Eastover Aquifer which has been referred to in some earlier reports as the Yorktown Aquifer, 3) the Aquifer System of Upper Cretaceous to Eocene age, and 4) the Lower Cretaceous Aquifer System. The Columbia Aquifer is a water table aquifer, and the other three are confined in most of this area.

Recharge to the water table aquifer is predominantly from precipitation. Of the annual average of 44 inches of precipitation, about 12 to 20 inches have been estimated to penetrate to the water table. Part of the water in the Columbia Aquifer discharges to surface-water bodies or to pumped wells, and part percolates slowly downward into underlying artesian aquifers through the confining beds. Most of the recharge to the

Table 2

Stratigraphy and Hydrogeologic Units of the Unconsolidated Formations

<u>Geologic Epoch</u>	<u>Group</u>	<u>Hydrogeologic Unit</u>	<u>Thickness (feet)</u>	<u>Lithologic and Hydrologic Characteristics</u>
Holocene Pleistocene	Columbia	Columbia Aquifer	20-40	Sand, fine to coarse, and gravel, commonly clayey; interbedded with silts and clays; groundwater generally unconfined, but confined locally. Yields water to domestic and small industrial wells.
Pliocene	Chesapeake	Yorktown Confining Bed	±300	Clay, silty and shelly; locally interbedded with fine sands.
		Yorktown-Eastover Aquifer		Sand, fine to coarse, commonly shelly; interbedded with clays, silts, and gravels; groundwater confined. Well yields adequate for small public and industrial supplies.
Miocene		Undifferentiated Confining Units	±300	Clay, silty and shelly; interbedded with fine sands.
Eocene Paleocene Upper Cretaceous	Undifferentiated	Undifferentiated Aquifers interbedded with Confining units	±200	Sand interbedded with clay and silt. Confined groundwater used infrequently for small to moderate supplies. Water brackish in most of the area.
Lower Cretaceous	Undifferentiated	Undifferentiated Aquifers interbedded with Confining units	1,600(?)	Interbedded gravel, sand, silt, and clay. Well yields adequate for large industrial supplies. Water brackish in most of the area.

* Modified from Siudyla and others, 1981; and Meng and Harsh, 1984.

artesian aquifers is from downward percolation from unconfined aquifers, but some is derived from lateral flow from the west. In the vicinity of the larger surface-water bodies, the artesian aquifers discharge water naturally by upward seepage through the overlying confining beds. In addition, water is discharged to pumped wells. Where pumping has lowered the potentiometric surfaces in the artesian aquifers below the water table, unconfined groundwater is induced to seep down into the confined aquifers.

1.A.5.2 Description of Aquifers at the Site

Columbia Aquifer

The Columbia Aquifer is interpreted to be the equivalent of the uppermost or water table aquifer which was described by Siudyla and others (1981, p. 18) as follows:

The water table aquifer consists of beds and lenses of sand and some gravel, shell beds, silt, sandy clay, and clay. The sand and shell beds and sand and shell lenses, the major water-bearing strata, are very heterogeneous and discontinuous due to the complex marine estuarine environments in which they were deposited....Geophysical and geologic logs indicate that the typical sand bodies in the water table aquifer consist of one or two beds or lenses of medium to coarse sand 5 to 10 feet thick.

Under natural conditions, before the site was developed for industrial purposes, the soils of the Columbia Group (Table 2) probably were in the soil association which Henry and others (1953) refer to as tidal marsh-mixed alluvial land. Although the soils on the site were not classified in this 1953 report, owing to the fact that the land was categorized as urban, it is reasonable to assume that most of the remnants of natural soils which

had not been excavated and backfilled are similar to those in adjacent areas upstream along the banks of the South Branch of the Elizabeth River. These soils, mostly loamy fine sands and sandy loams, together with the fill material, are hydraulically connected to the Columbia Aquifer.

The logs of shallow wells drilled in various parts of the site by Russnow-Kane & Associates, Inc., Newport News, Virginia (1985) and logs of wells at the Naval Shipyard Steam Plant northwest of the site indicate that the base of the shallow sandy strata is an extensive body of silty or sandy clay. The top of this body of clay, which is presumed to be the Yorktown Confining Bed, is from 15 to 20 feet deep, although in most of the wells it is at a depth of about 20 feet. The current status of the monitoring wells referenced in the Russnow-Kane & Associates report is in question, and these wells need to be physically examined and are considered of limited or no value in the RI/FS program.

A fence diagram of the eastern segment of the site (Figure 5 in Russnow-Kane & Associates 1985) indicates a bed of clay of variable thickness within the Columbia Aquifer. On some logs, however, this clay bed is described as dark gray peat or silty sand with clay lenses, rather than clay. The bed is as much as 10 feet thick in the central and western parts of this segment, but it thins and disappears to the south. In the northeastern part, however, it appears to thicken locally and to occupy most of the stratigraphic interval regarded as the Columbia Group in the vicinity of Well 5. As a result, the sandy

strata comprising the Columbia Aquifer are only about 10 feet thick in this area.

Water-level measurements by Russnow-Kane & Associates, Inc. (Figure 8 in 1985), made on October 23, 1984, in the eastern segment of the site, indicate that the water table varied in depth from about 1 to 5 feet. A comparison of water-level measurements made on June 15, June 29, July 26, and October 23, 1984, indicate that a net monthly rise of more than one foot can occur over most of the site. The water table fluctuations could indicate that the aquifer is readily recharged by rainfall or may be tidally influenced.

Water table maps for June 15, June 29, and October 23, 1984 (Figures 9, 10, and 11 in Russnow-Kane & Associates 1985) for the eastern segment of the site indicate that the local direction of groundwater flow can vary with time. Although the dominant direction is northeasterly, at times, there are components of flow to the north, east, and east-southeast. The water table aquifer discharges generally to the river.

No quantitative data are available on the hydraulic characteristics of the Columbia Aquifer at the site. Siudyla and others (1981, p. 31) report the results of calculations of transmissivity from a pumping test and a recovery test in a well about 15 miles southeast of the site as 2,600 gpd/ft and 1,400 gpd/ft, respectively. It is estimated from these data that the hydraulic conductivity at the site of these tests is about 10 feet per day, a value which is at the low end of the range for clean sands. The lithologic descriptions in the logs of wells on

the plant site, however, suggest that generally the sands are not clean.

Yorktown-Eastover Aquifer

This aquifer is heavily pumped by a number of users in the area. As of 1980, the nearest reported centers of pumping to the site were about 3 miles south, on the east side of the river, where the rate of pumping was 0.2-0.59 million gallons per day (mgd); and about 4 to 5 miles east, where the pumping rate was 0.6-0.99 mgd (Siudyla and others 1981, p. 78).

Water in the aquifer is confined under artesian pressure. Specific data on the lithology and thickness of the overlying confining bed materials are not currently available for the site. Siudyla and others (1981, p. 34) report that in the general area, the Yorktown Confining Bed consists of clay, marl, and sandy clay and is generally 20 to 40 feet thick. Hydrographs of observation wells indicate that the aquifer is recharged mainly by downward leakage from the water table aquifer where the potentiometric surface is below the water table. A smaller portion of the recharge is from lateral flow from the west.

No water-level data are available on the Yorktown-Eastover Aquifer at the site. It is estimated, in view of the proximity of the discharge zone along the nearby river, that the natural position of the potentiometric surface in this zone would be slightly higher than the water table. It is possible, however, that pumping has lowered the potentiometric surface at the site so that the water table aquifer is discharging downward to the Yorktown-Eastover Aquifer.

Based on pumping or recovery tests in 16 wells in the general area of Portsmouth, the aquifer transmissivity reportedly ranges from 16,000 to 66,000 gpd/ft with an average of 15,000 gpd/ft. It should be noted that the most permeable zones in this aquifer are in the upper 50 to 100 feet.

Aquifer System of Upper Cretaceous to Eocene Age

Water in this aquifer system is confined and generally brackish. About 15 miles southeast of the site, in the City of Chesapeake, 6 flowing wells were reported to obtain water from this source (Siudyla and others 1981, p. 55).

In view of the large thickness of the confining units between this aquifer system and the Yorktown-Eastover Aquifer, the brackish nature of the water, and the relatively high potentiometric surface, the aquifer system appears to be essentially hydraulically remote from the overlying aquifers at the site.

Lower Cretaceous Aquifer System

Although this aquifer system has a high potential for producing large quantities of water, the water reportedly is brackish in most of the area, including at the Atlantic Wood Industries site.

The aquifer system contains water under artesian pressure. It receives recharge by slow downward leakage from overlying aquifers and confining units. Owing to the occurrence of centers of heavy pumping to the west, recharge of brackish water is induced to move into the aquifer system from the east.

In 1980, the potentiometric surface in the aquifer system was reported to be at an elevation of about 40 feet below

mean sea level in the vicinity of the site (Siudyla and others 1981, p. 60). However, the aquifer system appears to be essentially hydraulically remote from the Columbia and Yorktown-Eastover Aquifers.

1.A.5.3 Relation of Groundwater Flow Patterns to Movement of Pollutants at the Site

The major raw materials from which contaminants have been derived are creosote and pentachlorophenol (PCP). Physically, the contaminants are in three phases: 1) an aqueous phase dissolved in groundwater; 2) a relatively heavy, nonaqueous phase (creosote); and 3) a light nonaqueous phase (pentachlorophenol). The movement characteristics of the aqueous-phase contaminants are essentially the same as those of groundwater. Creosote has probably seeped downward below the water table although the specific nature of the transport mechanism of the nonaqueous phase is obscure. Pentachlorophenol will float on the groundwater.

The problem of determining the potential for groundwater pollution by the aqueous contaminants is primarily to define their extent in the subsurface and the stratigraphic and hydraulic characteristics of the formations comprising the Columbia and Yorktown-Eastover Aquifers and the intervening Yorktown Confining Bed.

Russnow-Kane & Associates, Inc. reported on field observations of the occurrence of creosote in samples from test borings in the eastern segment of the site. These observations are poorly documented. In 12 test borings in the north central

part of this area, creosote was observed in samples from the Columbia Aquifer. All of these borings were downgradient from locations where wood treating chemicals had been stored in the four removed tanks, where tank-bottom materials are suspected to have been deposited, where a concrete oil/water separator basin was located, or where a tar distillation basin is located. In seven of these borings, creosote was observed only in sandy materials above the clay bed within the Columbia Aquifer; and in five of them, creosote was described in materials within this clay bed or in sandy materials below the clay bed. Even though the Russnow-Kane & Associates' report (1985) indicates a bed of clay within the Columbia Aquifer, some of the boring logs describe the material of this bed as peat or silty sand with clay lenses. It would appear, therefore, that only in some places does the so-called clay bed impede the downward movement of contaminants. This clay bed is within the Columbia Aquifer and is not the beginning of the Yorktown Confining Bed. There are no data on the occurrence of creosote compounds in the Yorktown Confining Bed.

The task of defining the subsurface extent of the contaminants must include the Yorktown Confining Bed and the underlying Yorktown-Eastover Aquifer. Test wells and monitoring wells installed to determine the distribution and concentration of contaminants and the stratigraphy must also be used to determine, at selected locations, the hydraulic conductivity of the more permeable strata and those which may serve to impede contaminant travel. Also, these wells must be used to obtain water-level

measurements in order to calculate hydraulic gradients and estimate the rate of movement of pollutants. In view of the fact that the water levels in some areas fluctuate with tidal forces, records of tidally influenced water-level fluctuations will have to be obtained to determine the extent to which they affect the rate of movement of contaminants.

The most obvious travel path of contaminants in the Columbia Aquifer is downward and then possibly laterally to storm sewers on Elm Avenue and to the river. A potential effect and one about which there are few data, if any, is the possibility of downward movement of contaminants through the Yorktown Confining Bed and into the Yorktown-Eastover Aquifer.

1.A.6 Vegetation

The AWI site is relatively devoid of vegetation. There is a small grassed area around the plant offices. There are no other managed grass or lawn areas and there are no wooded areas on site. There are isolated patches of wild grasses and weeds located throughout the site, particularly in drainage ditches, and upstream from the NPDES outfalls. Of note is the area around Outfall 001. This area appears marshy and evidence of Spartina alterniflora exists.

1.B Nature and Extent of the Problem

One significant problem at the AWI site, addressed in the Phase I Removal Plan, is associated with the Elm Avenue storm sewer. A portion of an old storm sewer which ran along the

southside of Elm Avenue was replaced in 1976. The old storm sewer (18-inch concrete pipe) was plugged in the vicinity of the (now removed) 880,000-gallon tank, which was where the pipe crossed the street to a discharge point north of Elm Avenue. Normal construction materials and techniques were used to replace and realign the storm sewer to the present discharge point just south of the Jordan Bridge. Creosote has been observed in the city storm sewer outfall. The Phase I Removal Plan prepared by Environmental Strategies Corporation (ESC) and submitted to US EPA Region III on September 21, 1987, addresses this potential contamination source.

EPA performed the first of several preliminary assessments in 1982. Outfalls 001 and 002, two on-site monitoring wells and an historic disposal area were sampled on August 18-19, 1982. In addition, EPA collected aqueous and sediment samples from outfall 002 during a July 17, 1984 site inspection. EPA also collected air samples from the site on July 18 and 19, 1985. AWI collected "split" samples during some of the EPA sampling efforts. Additionally, AWI installed and monitored wells located throughout the property as noted in Section 1.A.5. AWI has also sampled soils at the plant and performed monitoring at each of the three NPDES outfalls as required by the facility NPDES permit.

The results of the air, sediment, groundwater and surface water samples collected by EPA figured prominently in the HRS ranking for the site.

1.B.1 Major Constituents

Creosote has the longest history of use at the site. Pentachlorophenol was used at the site from about 1972 to 1985. In addition, site operators indicated to ESC that a special formulation of pentachlorophenol and creosote called creo-penta was used at the site from the late 1950s until about the early to mid 1960s.

1.B.1.1 Creosote

Creosote is produced by the processing of coal tar, which in turn is most often generated by either high or low temperature coal coking operations. Distillation is used to separate the coal tar into distinct fractions. Creosote is the middle fraction of the higher molecular weight organic aromatic compounds derived from the coal tar. The material with the highest boiling point collected along with creosote oil is anthracene oil.

The raw material and the production process can have profound effects on the composition of a creosote product. High temperature coking generates a coal tar with a higher ratio of total PAHs to total phenol. Creosote produced from such a coal tar product would have a similar ratio of total PAHs to phenol. Specific substances of coal tar may also be removed after distillation to produce a creosote which satisfies industry specifications for unique uses. For example, carbolineum is produced by retaining a fraction from the coal tar which boils at a higher temperature than ordinary creosotes. Liquid creosote is produced

by removing substances from the creosote which solidify at ordinary temperatures.

There are potentially thousands of substances present in creosote. Phenanthrene is the single most abundant component and is found at concentrations ranging from 12 to 14 percent. Substances present in the 2 to 4 percent range include carbazole, fluorene, acenaphthene, and anthracene. It is also not unusual to find cresols, xylenols, thiophenes, pyridines, and other sulfur and nitrogen substituted organics. Table 3 summarizes the principal substances in creosote, as discussed in the literature. Substances present at greater than one percent by weight of the total composition of typical creosote formulations are noted.

The inorganics present in creosote are also relevant for the purposes of this RI/FS work plan. As noted above, creosote formulations vary significantly according to the coal tar source, and the creosote production methods. As a result, the inorganic content of creosote is expected to vary accordingly. Table 4 summarizes a characterization of inorganics in creosote wastes from two sample creosote waste streams. A number of inorganic compounds were detected.

1.B.1.2 Pentachlorophenol

Pentachlorophenol (PCP) has been used at the site from about 1972 until December 1985. PCP is a commercially produced product used primarily for the preservation of wood and nonwood products. PCP is also used as an insecticide and herbicide.

Table 3

SUBSTANCES PRESENT IN CREOSOTE*

†	Acenaphthene
	Acetophenone
	Acridine
	Ammonium thiocyanate
	Aniline
†	Anthracene
	Benzo(a)anthracene**
4,5-	Benzoindane
	Benzo(a)pyrene**
	Benzo(b)chrysene**
	Benzo(e)pyrene
	Benzo(i)fluoranthene**
	Benzo(k)fluoranthene**
2,3-	Benzoofluorene (isonaphthofluorene)
1,2-	Benzonaphthacene (naphthofluorene)
1,2-	Benzonaphthacene
	Benzonitrile
9,10-	Benzophenanthrene
1,9-	Benzoxanthene
†	Carbazole
†	Chrysene
	Coumarone
	Cresol
p-	Cresol
m-	Cresol
2,3,5,6-	Dibenzocoumarone
†	Dibenzofuran (diphenylene oxide)
	Dibenzothionaphthalene
9,10-	Dihydroanthracene
2,7-	Dimethylantracene
3,6-	Dimethylcoumarone
4,5-	Dimethylcoumarone
4,6-	Dimethylcoumarone
3,4'-	Dimethyldiphenyl
4,4'-	Dimethyldiphenyl
3,4-	Dimethylethylbenzene
	Dimethylindane
1,3-	Dimethylisoquinoplene
2,6-	Dimethylnaphthalene
2,7-	Dimethylnaphthalene
1,7-	Dimethylnaphthalene
1,6-	Dimethylnaphthalene
1,5-	Dimethylnaphthalene
1,4-	Dimethylnaphthalene***
2,3-	Dimethylnaphthalene
1,2-	Dimethylnaphthalene
2,8-	Dimethylquinoline
5,8-	Dimethylquinoline
	Diphenylene sulfide
	Docosane
	Durene (1,2,4,5-tetramethylbenzene)

* Unless otherwise noted, all compounds are from Creosote: Special Review Position Document 2/3; USEPA: August 1984.

† Present at greater than one percent by weight of total composition.

** Lijinsky, W. et al, "The Chromatographic Determination of Trace Amounts of Polynuclear Hydrocarbons in Petrolatum, Mineral Oil, and Coal Tar," Analytical Chemistry, Vol. 35, pp.952-956.

***Nicolas, D., Wood Deterioration and its Prevention by Preservative Treatments: Volume II, Preservatives and Preservative Systems, Syracuse University Press, Syracuse, New York, 1973

SUBSTANCES PRESENT IN CREOSOTE*

- 9- Ethylanthracene***
- 3- Ethyl-5-methylphenol
- m- Ethylphenol
- p- Ethylphenol
- † Fluoranthene
- † Fluorene
- Heptacosane
- Heptacosane
- Hexacosane
- Hydrindene
- Hydroacridine
- Hydroxyanthracene
- 2- Hydroxybiphenylene oxide
- 7- Hydroxycoumarone
- 2- Hydroxyfluorene
- 4- Hydroxyhydrindone
- 2- Hydroxyphenanthrene
(2-phenanthrol)
- Indane
- Isodurene (1,2,3,5-tetramethylbenzene)
- Isopseudocumenol (2,3,5-trimethylphenol)
- Isoquinoline
- 2- Methylanthracene
- 2- Methylcarbazole
- 3- Methylcarbazole
- 6- Methylcoumarone
- 3 or 5- Methylcoumarone
- 4- Methylcoumarone
- 2- Methyl dibenzofuran
(2-methyldiphenylene oxide)
- 1- Methyl dibenzofuran
(1-methyldiphenylene oxide)
- 3- Methyldiphenyl
- 4- Methyldiphenyl
- 2- Methylfluorene
- 3- Methylfluorene
- 4- Methylindene
- 7- Methylindole
- 4- Methylindole
- 5- Methylindole
- 2- Methylindole
- 3- Methylindole (skatole)
- 5- or 7- Methylisoquinoline
- 6- Methylisoquinoline
- † 2- Methyl naphthalene
- 1- Methyl naphthalene
- 3- Methylphenanthrene
- 9- Methylphenanthrene
- 1- Methylphenanthrene
- 2- Methylquinoline
- 7- Methylquinoline
- 6- Methylquinoline
- 3- Methylquinoline
- 5- Methylquinoline
- 4- Methylquinoline
- Methylthionaphthalene

* Unless otherwise noted, all compounds are from Creosote: Special Review Position Document 2/3; USEPA: August 1984

† Present at greater than one percent by weight of total composition

** Lijinsky, W. et al, "The Chromatographic Determination of Trace Amounts of Polynuclear Hydrocarbons in Petroleum, Mineral Oil, and Coal Tar," Analytical Chemistry, Vol. 35, pp.952-956.

*** Nicholas, D., Wood Deterioration and its Prevention by Preservative Treatments: Volume II, Preservatives and Preservative Systems, Syracuse University Press, Syracuse, New York, 1973.

SUBSTANCES PRESENT IN CREOSOTE*

	Naphthacene
†	Naphthalene
	Naphtho-2',3',2-anthracene
a-	Naphthofurane
b-	Naphthofurane
a-	Naphthol
b-	Naphthol
1-	Naphthonitrile
	(1-cyanonaphthalene)
2-	Naphthonitrile
	(2-cyanonaphthalene)
1-	Naphthylamine
	Nonadecane
	Octacosane
	Paraffin (octadecane)
	Pentacosane
	Perylene
†	Phenanthrene
	Phenanthridine
	Phenanthridone
4,5-	Phenanthrylenemethane
	Phenol
2-	Phenylnaphthalene
1-	Phenylnaphthalene***
2-	Phenylnaphthalene
p-	Phenylphenol
o-	Phenylphenol
	Pseudocumenol (2,4,5-trimethyl-phenol)
†	Pyrene
	Quinoline (leucoline)
	Retene (8-methyl-2-isopropylphenanthrene)
	Sulfur
	Tetracosane
1,2,3,4-	Tetrahydrofluoranthene
	Tetrahydronaphthalene
	Tetramethylbiphenol
2,3,4,5-	Tetramethylpyridine
	(phenol)
	Thionaphthene
p-	Toluidine
o-	Toluidine
m-	Toluidine
	Tricosane
1,2,3-	Trimethylbenzene
1,3,7-	Trimethylnaphthalene
2,3,5-	Trimethylnaphthalene
2,3,6-	Trimethylnaphthalene
2,4,6-	Trimethylquinoline
	Triphenylene
	Truxene
n-	Undecane
2,4-	Xylenol
2,6-	Xylenol
2,5-	Xylenol
2,3-	Xylenol
3,5-	Xylenol
3,4-	Xylenol
2,4-	Xylidine
2,5-	Xylidine
3,5-	Xylidine
2,3-	Xylidine

* Unless otherwise noted, all compounds are from Creosote: Special Review Position Document 2/3; USEPA: August 1984.

† Present at greater than one percent by weight of total composition.

** Lijinsky, W. et al, "The Chromatographic Determination of Trace Amounts of Polynuclear Hydrocarbons in Petroleum, Mineral Oil, and Coal Tar," Analytical Chemistry, Vol. 35, pp.952-956.

*** Nicholas, D., Wood Deterioration and its Prevention by Preservative Treatments: Volume II, Preservatives and Preservative Systems, Syracuse University Press, Syracuse, New York, 1973.

Table 4
Inorganic Substances Found in Creosote Wastes¹

Metal	Waste D ²	Waste B ³
Total Metals mg/kg dry weight		
Osmium	~2.5	N/A ⁴
Thallium	~12.5	2.0
Arsenic	1.88	49.0
Mercury	~12.5	0.066
Selenium	~12.5	~0.01
Molybdenum	~1.25	N/A
Chromium	4.36	350.0
Antimony	~10.0	0.94
Zinc	62.7	518.0
Vanadium	3.26	N/A
Cadmium	~0.5	0.83
Lead	8.40	38.0
Nickel	3.70	10.0
Manganese	57.6	96.0
Beryllium	~0.1	N/A
Silver	~1.2	1.8
Strontium	9.92	N/A
Barium	252.0	42.0
Copper	15.1	937.0
Total Cyanide	N/A	6.0 ⁵
g/kg dry weight		
Iron	2.92	35.0
Aluminum	2.62	N/A

- 1/ Source - Environmental Research & Technology 1985. The analyzed creosote wastes are reported to be uncontaminated by inorganic wastes from other treatment processes.
- 2/ Average of 3 sludge samples, corrected for blank
- 3/ Average of 7 sludge samples
- 4/ No analyzed
- 5/ Only detected in one sample

PCP is produced by the chlorination of phenol. Chlorinated benzenes are reacted with sodium hydroxide or sodium carbonate at elevated temperatures and chlorinated phenols are then produced through hydrolysis. An alternative method relies on the same raw materials discussed above and the use of calcium phosphate or silicates as catalysts and higher temperatures for hydrolysis.

PCP is a crystalline solid with the following chemical/physical properties:

Chemical formula	C_6Cl_5OH
Molecular Weight	266.35
Melting Point Range	190-191° C
Boiling Point Range	309-310° C
Vapor Pressure	0.12 mm Hg at 100° C
Solubility	Water - 14 mg/l at 20° C

Commercial PCP is only 80 to 95 % pure: the remaining fraction of any particular formulation is likely to contain tetrachlorophenol and higher chlorophenols. Octa- and heptachlorodibenzo furans and dioxins, and other dioxin and furan homologs (excluding tetra-homologs) may be present in total concentrations of less than 0.1%. In addition, since PCP is relatively insoluble in water, it is usually mixed in a solvent such as petroleum oils for application. The additives and impurities likely to be present in commercial pentachlorophenol have been summarized in Table 5.

1.B.2 Site-Specific Constituents of Concern

The waste constituents that are considered likely to be found at the site are associated with past and current wood treating operations. Both creosote and pentachlorophenol have

Table 5

Commercial Pentachlorophenol: Additives and Impurities

SUBSTANCE	SOURCE	APPROXIMATE CONCENTRATIONS BY WEIGHT % OR PPM (PARTS PER MILLION)
2,3,4,6-tetrachlorophenol ^a	added to increase rate of solubility	4-8%
Higher chlorophenols ^a	byproduct of manufacture	2-6%
Dioxins:		
Octachlorodibenzo-p-dioxin ^b	byproduct of manufacture	210 ppm
Heptachlorodibenzo-p-dioxin ^b	byproduct of manufacture	54 ppm
Hexachlorodibenzo-p-dioxin ^b	byproduct of manufacture	4.2 ppm
Predioxins ^b	byproduct of manufacture	none given
Iao predioxins ^b	byproduct of manufacture	none given
Pentachlorodibenzofuran ^b	byproduct of manufacture	.10 ppm
Hexachlorodibenzofuran ^b	byproduct of manufacture	23 ppm
Heptachlorodibenzofuran ^b	byproduct of manufacture	160 ppm
Octachlorodibenzofuran ^b	byproduct of manufacture	140 ppm
Hexachlorobenzene ^b	byproduct of manufacture	none given
Chlorinated cyclohexenones ^b	byproduct of manufacture	none given
Cyclohexadienones ^b	byproduct of manufacture	none given
Trichlorophenols ^b	byproduct of manufacture	none given
Chlorinated phenoxyphenols ^c	byproduct of manufacture	none given
Diphenyl ethers ^c	byproduct of manufacture	none given
Dihydroxybiphenyls ^c	byproduct of manufacture	none given

^aMcGinnis, G., "Biological and Photochemical Degradation of Pentachlorophenol and Creosole," Hazardous Waste Treatment and Disposal in the Wood Preserving Industry, Proceedings from the Symposium On; March 6, 1984, pp.115-137.

^bCrosby, P., "Environmental Chemistry of Pentachlorophenol," Pure and Applied Chemistry, vol. 53, No. 5, pp. 1052-80, May 1981.

^cPlimmer, J., "Technical Pentachlorophenol: Origin and Analysis of Base-Insoluble Contaminants," Environmental Health Perspectives, pp. 41-41, Sept. 1973.

been used at the site; however, AWI ceased using PCP in about December 1985. Chromated Copper Arsenate (CCA) has not been used at the site, but timber treated with this compound has been stored on site. Reportedly, the four wood treating facilities located in proximity to AWI, Wyckoff, Eppinger and Russell, Republic Creosoting, and Bernuth Lembcke, used many of the same wood treating chemicals that have been used by AWI. In general, various combinations of the following broad classes of compounds were found in some or all of the samples collected at the site: PAHs, PCP and other substituted phenols, phenol, volatile organics, or inorganics.

Appendix VII of 40 CFR Part 261, Identification and Listing of Hazardous Waste, establishes the basis for listing hazardous wastes. The listing for K001 wastes (bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol) provides a good starting point for contaminants of interest. These constituents include:

Pentachlorophenol	Fluoranthene
Phenol	Benzo(b)fluoranthene
2-Chlorophenol	Benzo(a)pyrene
p-Chlorophenol-m-cresol	Indeno(1,2,3-cd)pyrene
2,3-Dimethylphenol	Benz(a)anthracene
2,4-Dinitrophenol	Dibenz(a)anthracene
Trichlorophenol	Acenaphthene
Tetrachlorophenol	Naphthalene
Creosote	Chrysene

The ACO specifies sampling and analysis for the following constituents, many of which are included in the K001 list:

- Polycyclic aromatic hydrocarbons (PAHs)
- Pentachlorophenol (PCP)
- Phenols
- Naphthalene

Benzo(a)pyrene (BaP)
Phenanthrene
Total chlorinated dibenzo-p-dioxins (PCDDs)
Total chlorinated dibenzofurans (PCDFs)

The constituents specified in the ACO have been selected as analytes for sampling performed during the implementation of the RI/FS Work Plan. ESC also proposes that some samples be analyzed for total organic carbon (TOC), total petroleum hydrocarbons (TPH), total organic halogens (TOX) and phenol as surrogate indicator analytes for the more specific analytes specified above. Statistical analyses will be used to determine the efficacy of these surrogates. In addition, given that CCA treated wood has been stored at the site, it is also appropriate to evaluate some samples for inorganic constituents such as chromium, copper and arsenic and any additional inorganic constituents deemed appropriate. In order to preclude the introduction of site characterization bias, ESC also proposes to evaluate a number of samples for the full array of TCL analytes. The selection process for samples to be analyzed for the TCL analytes is described in Section 2.0. The relevant analytical methodologies for the analytes described above have been summarized in the companion document to this RI/FS Work Plan entitled "Quality Assurance Plan for the Removal Plan and RI/FS Work Plan."

1.B.3 Summary of Health and Environmental Effects

The health and environmental effects caused by the AWI site are unknown. The Properties of Materials section of the Health and Safety Plan developed for the site summarizes the

chemical and physical properties and potential impacts to biological and human receptors for the primary constituents of concern at the site. An Endangerment Assessment will be prepared as part of the RI/FS Work Plan implementation. The Endangerment Assessment will identify potential receptors and associated risks posed by current site conditions. Preparation of the Endangerment Assessment, including a preliminary review of potential receptors, is described in Section 5.0. The RI/FS Work Plan has been crafted to help determine the potential for adverse health and environmental effects.

1.C Site Boundary Conditions and Site Map

AWI had a detailed topographic map of the site prepared as of July 26, 1985, which delineates the site boundaries. The map was prepared at a scale of 1 inch = 100 feet with a contour interval of one foot. This map depicts the locations of all existing monitoring wells, utility poles, buildings, railroad spurs, tanks, roadways and surface water drainage features (Appendix A).

AWI has also prepared a more detailed survey map of the northern border of the site than had been available previously (dated May 30, 1987). The survey map was prepared at a scale of 1 inch = 20 feet and although there are no contour lines, there are numerous elevations on the map. The map also depicts above-ground and underground utilities, roadways, buildings, railroad spurs, and surface water drainage features (Appendix B).

AWI has an off-site access agreement with the City of Portsmouth (Appendix C). The need for the off-site access agreement is reflected in the Phase I Removal Plan. In order to meet the requirements in the ACO for soil characterization and remediation, a significant number of soil sample locations located immediately north of AWI property but south of Elm Avenue and within property owned by the City of Portsmouth were proposed. To meet the requirements in the ACO regarding the Phase II effort, sample locations located off-site in the receiving waters for outfall 002 have been proposed. At this time, it is unknown if additional off-site sampling locations will be required. As a result, the majority of the site characterization effort will take place within the existing AWI facility boundaries.

2.0 PLANS AND MANAGEMENT

2.A Objectives and Technical Approach

The objectives of the RI/FS Work Plan are as follows:

- Define the characteristics and locations of contamination sources on site.
- Characterize and evaluate the potential for air, soil, ground water, surface water and stream sediment to act as pathways for the off-site migration of contaminants.
- Define the impact of the AWI site on receptors including humans, and natural environmental conditions.

Data collected during the remedial investigation will be used in the performance of an endangerment assessment and will also be used in the feasibility study. ESC views the remedial investigation as a phased sequence of efforts directed at meeting the objectives established above.

2.B On-Site Sampling Plan

The locations, types and numbers of samples to be collected and analyzed and the rationale used in developing this sampling plan have been presented. A sampling plan for the receiving waters of outfall 002, otherwise known as the "inlet," and portions of the Elizabeth River in the vicinity of the AWI site has been included immediately following this section (River/Inlet Sampling Plan). This section addresses more of the on-site soil, groundwater, surface water, sediment and waste sampling efforts that will be performed.

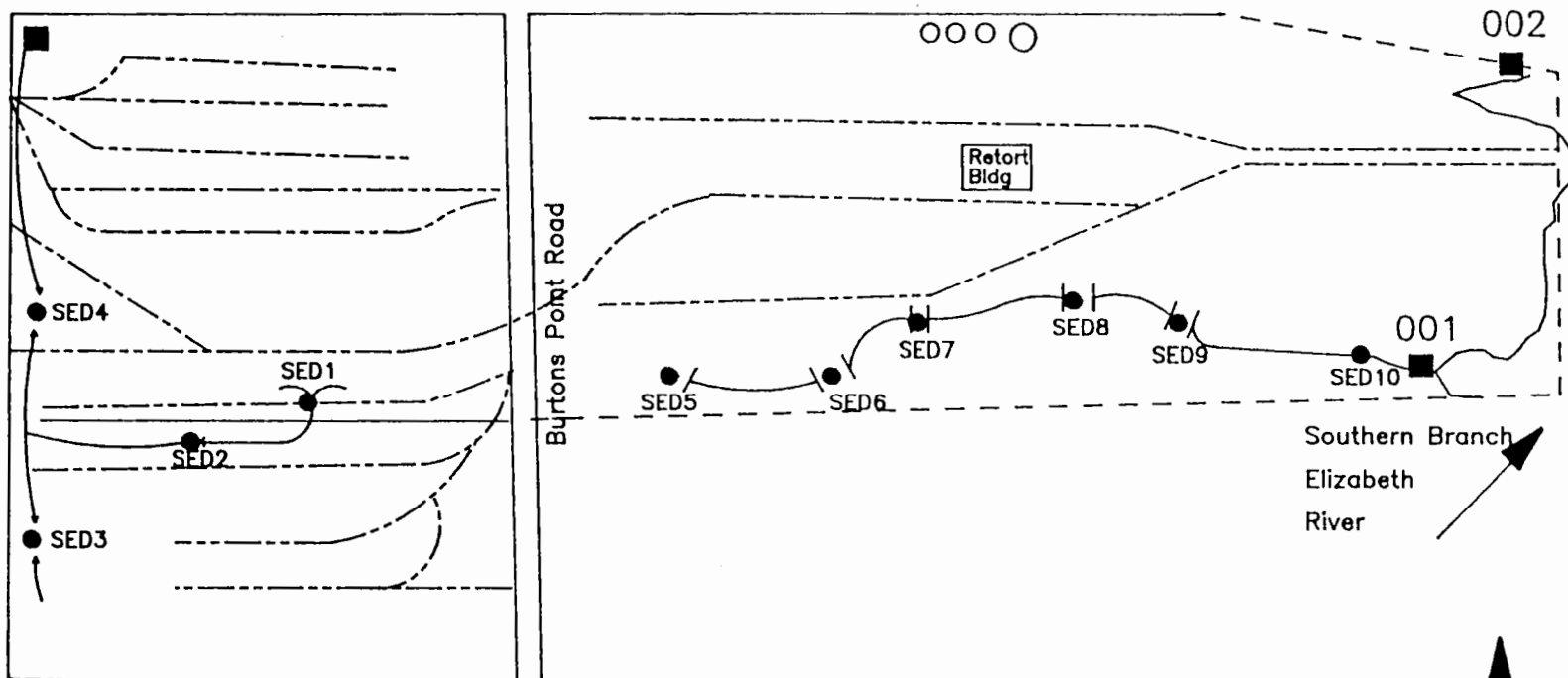
The choice of sediment sample locations will be determined based on the configuration of the surface water drainage features. The predominant surface water drainage features have been noted on Figure 8. These drainage features are associated with the three NPDES outfalls and, hence, have been designated Ditch 001, 002, and 003. Since the AWI Removal Plan includes an exhaustive sampling effort for drainage associated with outfall 002, the RI/FS sediment sampling effort focuses on Ditch 001 and Ditch 003.

Sediment samples from Ditch 003 will be collected at a minimum of four locations (Figure 8). The justification for the number of samples is that sample locations selected represent hydraulic restrictions where sediments are known to collect. As a result, these areas will provide "worst case" samples of sediment contamination. Three of the samples will be analyzed for the abbreviated TCL constituents discussed in Section 2.B.3.1 (Table 7). One of the four samples that appears to be the "worst case" sample will be analyzed for the full TCL.

Sediment samples will be collected at a minimum of 6 locations in Ditch 001 (Figure 8). The justification for the number of samples is that the locations represent hydraulic restrictions where sediments are known to collect. In addition, location SED 10 is an area where piles of material resembling partially set concrete were placed by the Navy. As a result, the locations selected will provide "worst case" samples of sediment contamination. The samples also will be analyzed for the abbreviated TCL constituents list. One of the "worst case" six samples will be selected and be analyzed for the full TCL.

003

Elm Avenue



- Sediment Sampling Locations
- Locations of NPDES outfalls
- Railroad tracks (only some shown)
- Former locations of large aboveground tanks (scale approximate)



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Figure 8

Locations of NPDES Outfalls 001 - 003 &
 Sediment Sampling Locations

As previously noted, there is an extensive pile of material at the downstream limit of Ditch 001. Sampling of this material is addressed in subsequent sections of the RI/FS Work Plan. At this time, no additional samples will be collected "downstream" of the material pile. As recommended by the Bioassessment Task Group (Appendix H), the sampling effort for the Southern Branch of the Elizabeth River is to focus on the receiving waters in the vicinity of outfall 002. The interpretation of the analytical results from this area vis-a-vis the significance of AWI as a source of estuarine contamination will be difficult given the number of potential off-site sources of contamination. Data interpretation for outfall 001 becomes even more complicated given the presence of the material piles discharged by the Navy in the past (see Section 1.A) and the proximity of the Naval Shipyard.

Sampling and other investigatory procedures are discussed in the companion document "Quality Assurance Plan for the Removal Plan and Remedial Investigation/Feasibility Study Work Plan."

2.B.1 Review of Background Information

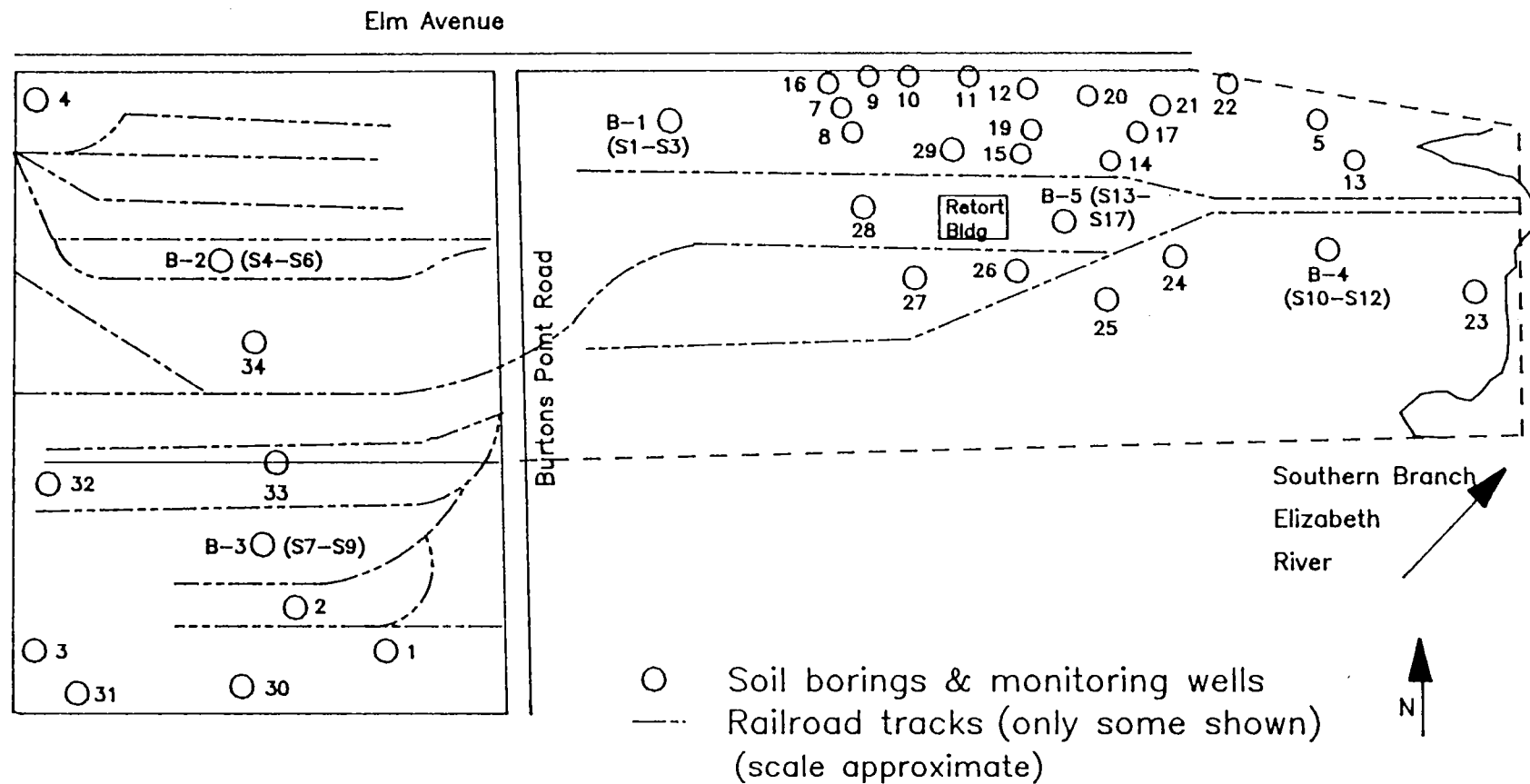
In order to justify the proposed elements of this RI/FS Work Plan, some analysis of existing information is necessary. As previously stated, existing data were only relied on in a gross and tentative fashion due to their questionable validity. The existing information is summarized by media in Appendices D through J.

A total of 34 groundwater monitoring wells have been installed at the site by AWI. Although these wells were constructed primarily for taking water level measurements, groundwater samples have been collected and analyzed on a number of occasions. The locations of the monitoring wells are shown on Figure 9 and the groundwater data are summarized in Appendix D. The installation dates and construction data for all of the wells installed by AWI are not readily obtainable and require additional research as part of the RI/FS investigation.

The EPA preliminary assessment, dated August 18, 1982, contains analytical results from samples collected from two on-site monitoring wells.

The analytical results indicate that PAHs in trace amounts (<30 ppb) were detected in monitoring well no. 5. In addition, substituted phenols and phenol were detected in well no. 4 at concentrations <20 ppb. Five wells which no longer exist (Figure 12) were sampled by AWI on or about August 26, 1981. The monitoring results are of limited value, but do indicate the presence of phenols, and PAHs in wells no. 1 and 2 and the presence of PAHs in wells no. 3 and 4 (Appendix G). The analyses of the groundwater sample collected from well no. 5 did not detect any of the K001 parameters. These wells (Figure 12) were subsequently abandoned or replaced with additional wells.

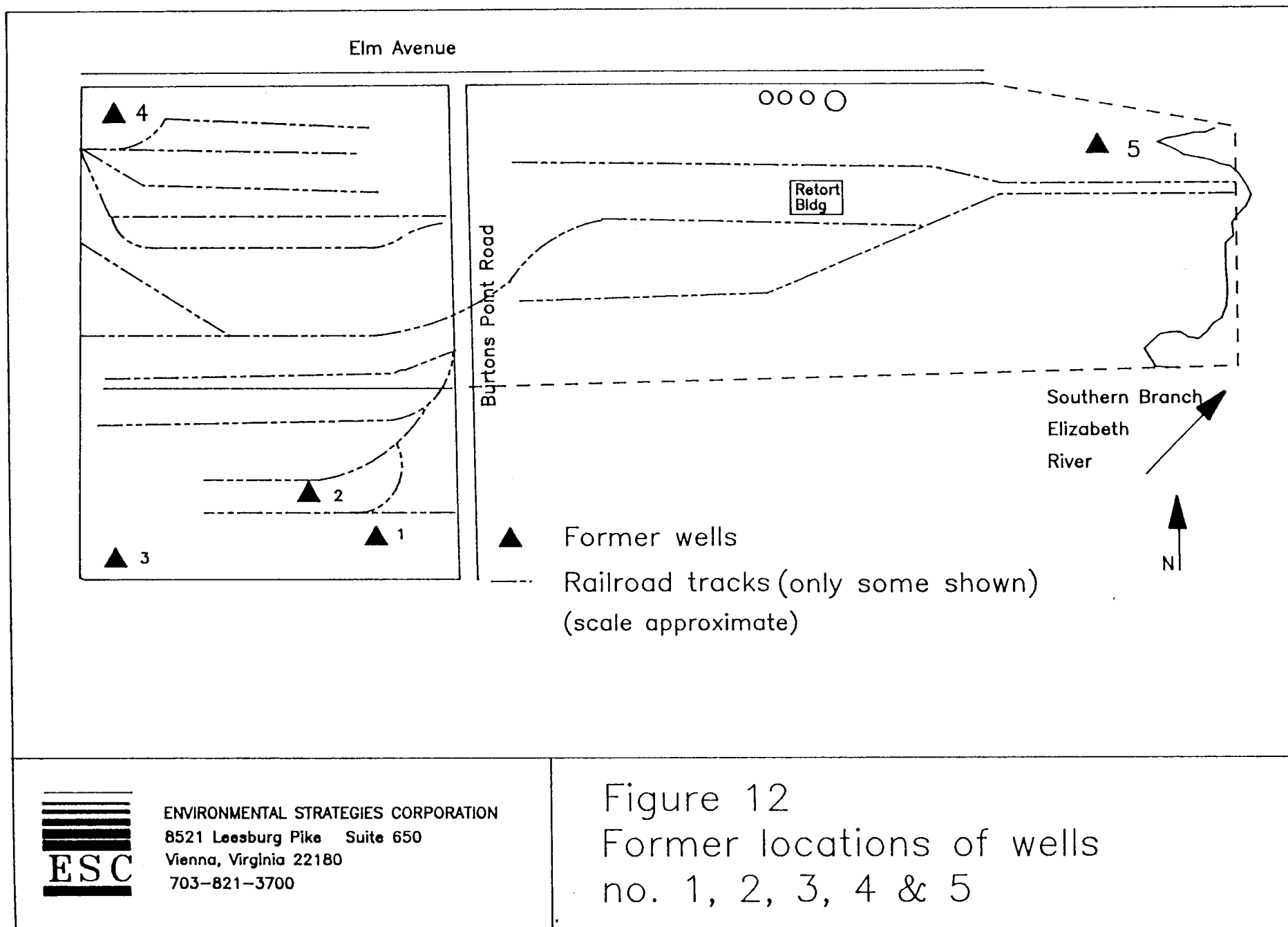
AWI also collected additional groundwater samples from the site in 1985. These wells were only sampled once. Wells no. 5, 7-11, 13, and 15-29 were sampled for phenols, selected PAHs, pH, specific conductance, and arsenic, chromium, and copper (Appendix H).



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Figure 9

Well and boring locations from
 Russnow & Kane report (1985)
 and other sources



Either naphthalene or phenanthrene was detected in all of the wells except 13 and 23. Naphthalene concentrations ranged from nondetectable to a high of 25 ppm in well 26. Phenanthrene concentrations ranged from nondetectable to a high of 1.4 ppm in wells no. 26 and 27. Pentachlorophenol was detectable in wells no. 17, 19, 29 and wells no. 24-27. The PCP concentrations ranged from nondetectable to a high of 13 ppm in well no. 17.

Reportedly, wells no. 30-34, located at the southwest corner of the property, have never been sampled. Nevertheless, AWI did have soil samples collected and analyzed during the installation of wells no. 31-34 (Appendix E). These samples were analyzed using EPA methodologies 8040 and 8100. Samples from borings 31-33 are relatively free from contamination. Samples from boring 34 do contain appreciable amounts of PAHs that generally increase with depth. At intervals of 0-1.5 feet and 8.7-9 feet, total PAH levels were 60 mg/kg and 1,742.8 mg/kg.

ESC is also aware of the analytical results of several soil samples which were reportedly collected from other areas located throughout the site. These samples were apparently collected from various depths using a hand auger. The samples were collected from the following depths in 5 borings designated B1 through B5.

	<u>B-1</u>		<u>B-2</u>
S-1	1 to 2 feet	S-4	0 to 1 feet
S-2	3 to 4	S-5	1 to 2
S-3	0 to 1	S-6	3 to 4
	<u>B-3</u>		<u>B-4</u>
S-7	0 to 1 feet	S-10	0 to 1 feet
S-8	1 to 2	S-11	1 to 2
S-9	3 to 4	S-12	3 to 4

B-5

S-13	0 to 6 inches
S-14	6 to 12
S-15	5 to 17 (boring collapsed)
S-16	18 to 24
S-17	30 to 45

The approximate locations of the borings have been designated on Figure 9.

Samples S-1 through S-3 were collected from an area near the plant office building that is unaffected by operations at the site and is meant to represent background concentrations for the constituents analyzed. Except for the samples from the surface soils, these samples seem relatively free from contamination.

Borings 2, 3 and 4 were collected from areas used for the storage of treated wood and untreated wood. Samples from Borings 2 and 3 (samples S-4 through S-9) are also free from contamination. The surface soil sample from Boring 4 (sample S-10) is the only sample in the boring with significant contamination. The boring locations are shown on Figure 9. The total PAH concentration in the sample is 1,768 mg/kg.

All of the samples from Boring B-5 have significant PAH contamination. These samples were collected from the area where treated wood is staged immediately after it is removed from the retort. The total PAH concentrations were highest in the samples from 0 to 6 inches (22,874 mg/kg) and 6 to 12 inches (15,567 mg/kg). PAHs were also detected in the deepest two samples at concentrations of 557 and 809 mg/kg. In addition, PCP concentrations ranged from 24 to 640 mg/kg and were highest in the deepest sample. A soil sample was collected from the historic disposal area as part of the EPA preliminary assessment.

Samples from outfalls 001 and 002 were also collected during the EPA preliminary assessment. The outfall testing indicated that PAHs were present at low concentrations (<30 ppb) in both outfalls.

Analytical results from a subsequent EPA site inspection on July 17, 1984, have been referenced in the HRS ranking (Reference 8). Aqueous samples were collected from a point in the storm sewer upgradient from the site and from points upstream and downstream of the outfall 002 filter fence. Sediment samples were collected from points upstream and downstream of the outfall 002 filter fence. The samples were analyzed for selected priority pollutants (Appendix F). The sample results indicate the presence of volatile organics, PAHs and other semivolatiles, particularly in the sediment samples collected upstream and downstream of the outfall. The credibility of the data is questionable however, since the sum of the constituents detected exceeds 100%. For example, total PAHs in sediment downstream of the filter fence exceeded 440%.

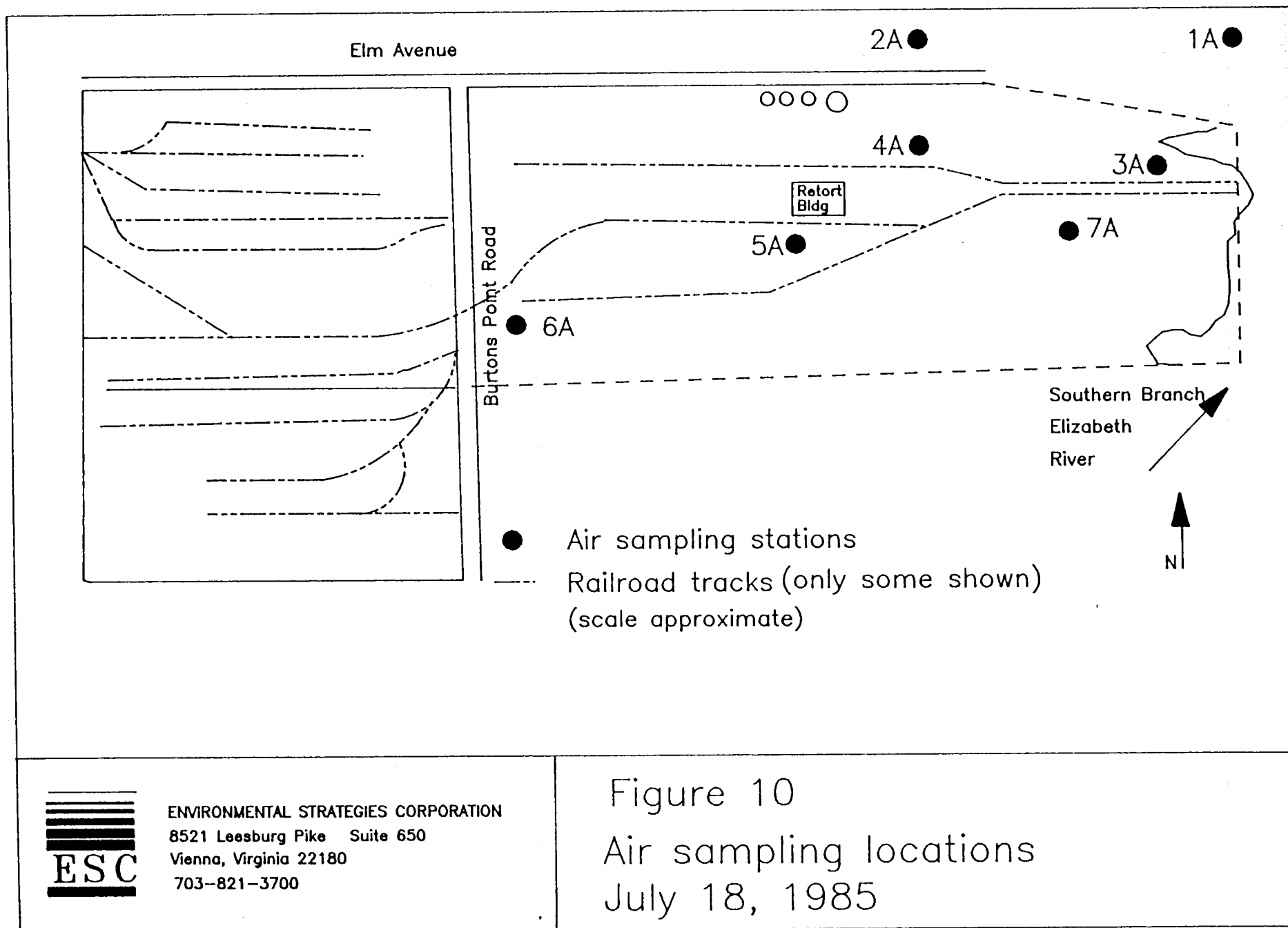
Additional surface water data have been collected in conjunction with the National Pollution Discharge Elimination System (NPDES) permit. The current NPDES permit and collected data are included in Appendix F. The permit requires chemical characterization of surface water discharges from the three outfalls, annual bioassays conducted on the two outfalls discharging directly into the South Branch of the Elizabeth River and discharge monitoring for pH, total phenols, and oil and grease.

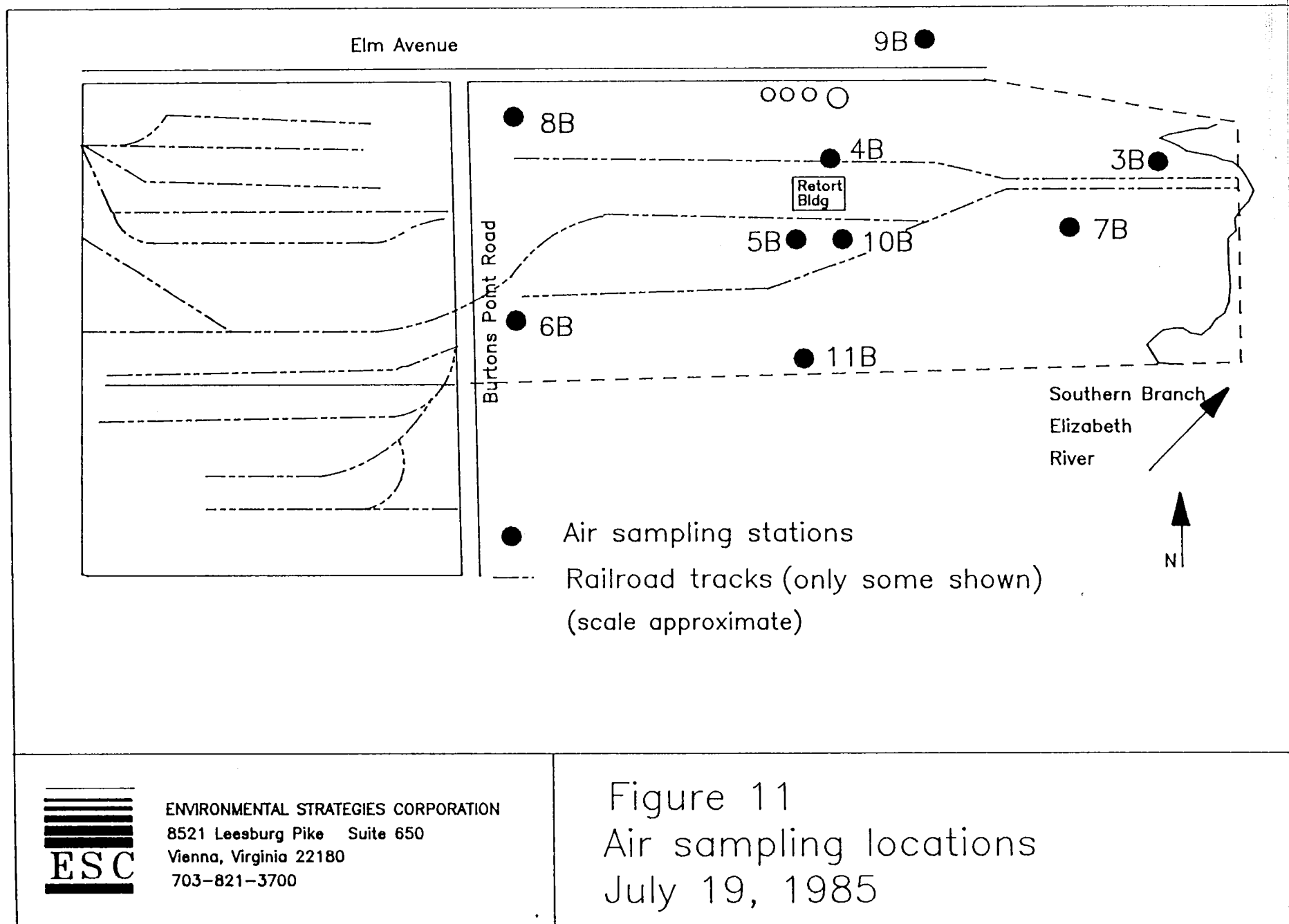
The NPDES data indicate that the discharges from outfalls 001 and 002 periodically contain pentachlorophenol and creosote compounds. Surface water discharges from outfall 003 contain considerably lower concentrations than outfalls 001 and 002 and only infrequently have detectable concentrations of the compounds analyzed.

The EPA conducted an air sampling investigation on July 18 and 19, 1985. An AWI representative took replicate air samples at the locations sampled by EPA (Figures 10 and 11). The results of the EPA sampling effort and the AWI sampling effort have been summarized in Appendix H. ESC submitted a detailed critique of the air sampling results in response to the original proposal to list the site on the NPL (Discussion of EPA Air Sampling and Results at Atlantic Wood Industries, Inc., Portsmouth, Virginia, August 7, 1986). In general, EPA used the naphthalene levels detected at the south boundary fence (site 11) to demonstrate the off-site migration of hazardous substances in the HRS scoring for the site.

Migration Pathways

Although it would be desirable to develop a representation of migration pathways, the existing data are scattered and deemed relatively unreliable. The only definitive migration pathway is for surface water and is represented by the natural topography of the site, which culminates in drainage ditches 001, 002, and 003, as previously described. Migration pathways for groundwater, within the subsurface soils, or in the air remain to be defined through data collection in the RI/FS process.





ARARs

Site-specific applicable or relevant and appropriate requirements (ARARs) have been developed on a preliminary basis. The preliminary ARARs listed in Table 6 are a compilation of criteria for the chemical compounds identified at the AWI facility. The criteria include Federal and State of Virginia regulations, guidance, and advisories for groundwater and surface water.

At this stage, the purpose of developing the ARARs is not to set the cleanup criteria for the site, but to understand the universe of requirements potentially applying to the site. The existing data are not compared to the preliminary ARARs because of the questionable validity of the data gathered to date.

As the RI/FS process progresses, the ARARs will be updated to be consistent with developing regulations. The preparation of the FS will include assessing the updated ARARs and recommending final requirements to use as cleanup criteria. The recommended cleanup criteria will be used during the alternative analysis and comparison stage of the FS.

2.B.2 Utility of Existing Data and Data Gaps

In the relatively few instances that EPA collected and analyzed samples from the site, it appears that a QA/QC review was performed. The majority of the analytical data produced by AWI was generated before the listing of the site on the NPL. As a result, laboratory deliverables were only infrequently

Table 6

**Site-Specific Applicable and Relevant or Appropriate Requirements (ARARs)
for Groundwater and Surface Water**

Parameter	Freshwater Acute ¹	Toxicity Chronic	Salt Water Acute ¹	Water & Toxicity Chronic	Fish Ingestion ¹	Ingestion Only ¹	MCL ²	Acceptable Proposed MCLG ²	Unit Daily Intake ³	Cancer Risk ⁴	VA Surface Water VA Ground Water ⁵	Fresh Water	Salt Water
Acenaphthene	1,700 ⁶	520 ⁶	970 ⁶	710 ⁶	---	---	---	---	---	---	---	---	---
Naphthalene	2,300 ⁶	620 ⁶	2,350 ⁶	---	---	---	---	---	9,000	---	---	---	---
Fluoranthene	3,960 ⁶	---	40 ⁶	16 ⁶	42	54	---	---	210	---	---	---	---
Pentachlorophenol	20 ⁷	13 ⁷	13	7.9 ⁶	1,010	---	---	220	1,050	---	---	---	---
Phenol	10,200 ⁶	2,560 ⁶	5,800 ⁶	---	3,500	---	---	---	3,500	---	---	---	---
2-Chlorophenol	4,380 ⁶	2,000 ⁶	---	---	---	---	---	---	---	---	---	---	---
4-Chlorophenol	---	---	29,700 ⁶	---	---	---	---	---	25	---	---	---	---
Chloro-4-methyl 1-3-phenol	30 ⁶	---	---	---	---	---	---	---	---	---	---	---	---
2,4-Dichlorophenol	2,020 ⁶	365 ⁶	---	---	3,090	---	---	---	---	---	---	---	---
2,3,5,6-Tetrachloro- phenol	---	---	---	440 ⁶	2,600	---	---	---	---	---	---	---	---
2,4,5-Trichlorophenol	---	---	---	---	1.2 ⁸	3.6 ⁸	---	---	3,500	2 ¹¹	---	---	---
Total PAHs	---	---	300	---	0.0021 ⁸	0.0311 ⁸	---	---	---	0.00303	---	---	---
Total Phenols	---	---	---	---	---	---	---	---	---	---	1.0	1.0	1.0
Chromium (trivalent)	1,700 ⁹	210 ⁹	10,300 ⁶	---	170,000	3,433,000	50	120	62,500	---	50	74 ⁹	---
Copper	18 ⁹	12 ⁹	2.9	2.9	---	---	---	1,300	---	---	1,000	10.8 ⁹	2.0
Arsenic	360 ¹⁰	190 ¹⁰	69 ¹⁰	36 ¹⁰	0.0022 ⁸	0.0175 ⁸	50	50	---	0.0025	50	72 ¹⁰	63
Zinc	120 ⁹	110 ⁹	95	86	---	---	---	---	7,500	---	50	47	58

All values reported in ug/l.

1/ Water Quality Criteria for Water, 1986, EPA 440/5-86-001, May 1986.

2/ Maximum contaminant levels (MCLs) and proposed maximum contaminant level goals under the Safe Drinking Water Act (SDWA) 1986 amendments and resulting regulations.

3/ Summary of current oral acceptable intakes (ADIs) for systematic toxicants, Internal Review Draft, ECAO-Cin., USEPA, February 1984. ADIs are based on an exposure of 2 liters of water consumed per day by a 70 kg adult.

4/ Water Quality Criteria Documents: Availability, Federal Register 45:79318-79379, November 28, 1980. UCR values correspond to a 10⁻⁶ risk level based on an exposure of 2 liters of water consumed per day by a 70 kg adult.

5/ State of Virginia water quality standards.

6/ Insufficient data to develop criteria; value listed is the lowest observable effect level.

7/ pH dependent criteria for carcinogens at 10⁻⁶ risk level.

8/ Human health criteria for carcinogens at 10⁻⁶ risk level.

9/ Hardness dependent criteria (100 mg/l used).

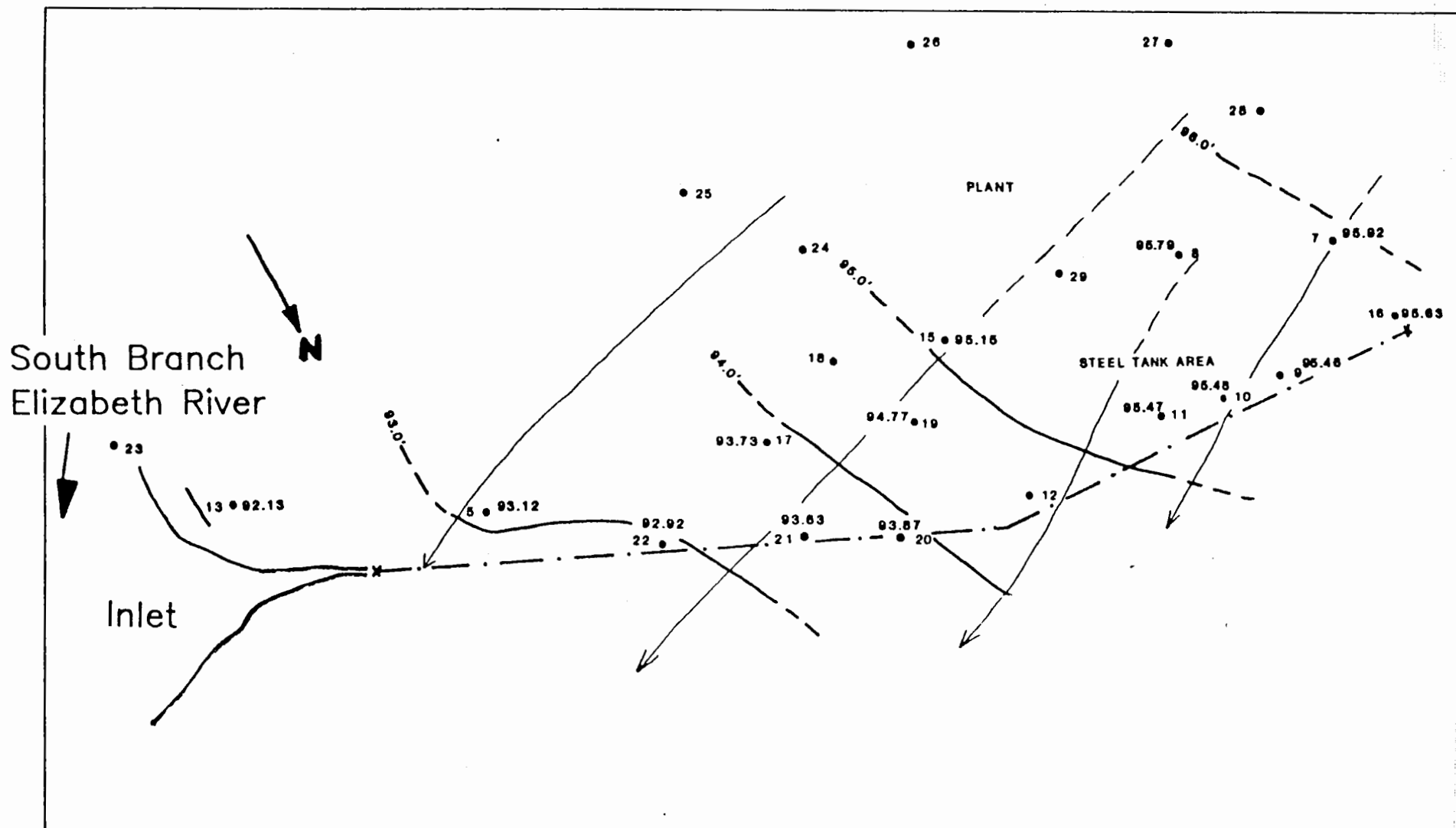
10/ Value reported for trivalent arsenic species.

11/ Value reported for 2,4,6-trichlorophenol.

generated. Thus, it is impossible to validate much of this existing information. In addition, it has been reported to ESC that none of the monitoring wells installed by AWI were grouted, which casts significant doubt on the credibility of the groundwater monitoring data. Nevertheless, the data generated by AWI, in conjunction with information about the site background, are useful in determining the locations, and types of samples needed to perform the RI/FS.

When the available information is examined in light of the objectives of the sampling plan, data gaps are found that need to be filled. Although there are numerous monitoring wells, little is known about the hydrogeology of the site. The utility of the analytical data has already been discussed. In addition, the monitoring wells on site were installed primarily for making water-level measurements. The screened sections were sealed from the shallow portions of the wells with bentonite, but the casings were not grouted. The absence of grout behind the well casings precludes using the wells for obtaining reliable water samples.

The dominant direction of groundwater flow in the vicinity of the Elm Avenue storm sewer appears generally to the northeast (Figure 13). Figure 13 is taken from data compiled by Russnow (1985). The basis for the assumed flow direction (e.g., water level measurements or other data) is not available. The map is presented as the best available information on the groundwater gradient at the site. Nevertheless, the following information about the hydrogeology of the site appears needed:



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Figure 13
 Groundwater Flow Map

1. Groundwater flow rates and directions, and water quality upgradient and downgradient of the site and upgradient and downgradient of potential contamination sources.
2. Stratigraphic and hydraulic characteristics (including tidal influence) of the formations associated with fill areas on the site, the Columbia Aquifer, Yorktown Confining Bed and the Yorktown-Eastover Aquifer. Specifically, emphasis must be placed on the effectiveness of clay beds in the Columbia Aquifer, and of the Yorktown Confining Bed, as barriers to contaminant travel.
3. Subsurface flow patterns of aqueous contaminants which would move with the groundwater, as opposed to the flow patterns of nonaqueous contaminants that are heavier or lighter than water.
4. The head relationship between the Columbia Aquifer and the underlying Yorktown-Eastover Aquifer, and the potential for future change as a result of pumping from the deeper aquifer.

These data items will provide the types of information required to prepare the FS and the Endangerment Assessment. Both documents require interpretation of hydrogeologic and geologic data to discern contaminant transport modes in the subsurface underlying the site. Understanding contaminant transport is essential to the identification of exposure routes and the development of remediation alternatives.

2.B.3 Exploratory Drilling and Sampling Plan

The Phase I Removal Plan previously submitted on the behalf of AWI proposes the collection and analyses of numerous samples from fill, soil, and shallow strata, collectively referred to as soils, which are in the path of the proposed and existing storm sewers along Elm Avenue. Additional information regarding the contaminant burden from soils throughout the site is also needed because these contaminants could be a source of groundwater contamination.

Before outlining the specific features of the plan for collecting the additional information, it is useful to briefly summarize the most significant characteristics of the hydrogeology.

- Pollutants have gotten below the water table in the Columbia Aquifer which is about 20 feet thick.
- In places, a thin bed of clay or clayey sand within the Columbia Aquifer appears to have impeded downward seepage of pollutants, but in other places, it may not be an effective barrier.
- The underlying Yorktown-Eastover Aquifer, the most heavily developed in the area, is separated from the Columbia Aquifer by a 20- to 40-foot confining bed which appears to be permeable enough to readily convey water downward where the potentiometric surface is below the water table.
- Both aquifers discharge to the tidal South Branch of the Elizabeth River.

For convenience, the plan is discussed in two parts: 1) definition of the extent of contamination and the physical characteristics of the soils, and 2) determination of the extent of groundwater contamination and the hydraulic characteristics of the Columbia and Yorktown-Eastover Aquifers and intervening confining strata.

2.B.3.1 Soils

The EPA generated soil monitoring results for the historic disposal area are useful in that they suggest that K001 type parameters exist in the subsurface. The exact depth intervals sampled and the sample collection techniques used by EPA are not available, however. The soil monitoring data generated by AWI are also useful as a starting point in determining the vertical and horizontal extent of soil contamination at the site. The use of a hand auger to collect samples, however, may have had a significant effect on the sample results. Unless extreme care is exercised, a hand auger can cause significant "drag down" as progressively deeper depth intervals are sampled. This casts doubt on the analytical results for intervals deeper than surface soils. In addition, the deepest depth sampled by AWI is 30 to 45 inches, which is considerably higher than the top of the Yorktown Confining Bed, the formation containing the first effective clay barriers to the downward migration of contaminants. Nevertheless, except for the problems with analytical results previously described, the results of previous analyses of soil samples are useful in highlighting areas requiring additional characterization.

There are several areas on site that are suspected to have been affected by tank bottoms. The analyses of soil samples in these areas will be critical in assessing on site soil contamination and will also facilitate waste characterization tasks. As suggested by AWI, soils in other areas on site may have become contaminated by actual wood treating operations, such as in the vicinity of the treatment retorts, in proximity to the oil/water separator, and in and around treated wood storage areas. Information is also needed on the contaminant burden of soils in areas presumed to be unaffected by site operations.

In order to evaluate the significance of stormwater runoff as a mechanism for the off-site migration of contaminants, on-site sampling of sediments will be included in the sampling effort. Surface water drainage features that convey runoff from areas with contaminated soil will be sampled.

In summary, exploratory drilling and sampling programs are needed to:

1. Determine background concentrations of selected organic and inorganic constituents at the site.
2. Determine the horizontal and vertical extent of contamination in areas close to the Elm Avenue storm sewer, but not addressed by the Phase I Removal Plan.
3. Determine the horizontal and vertical extent of contamination in those portions of the site which were allegedly used as tank-bottom disposal areas, and in all historic disposal areas.

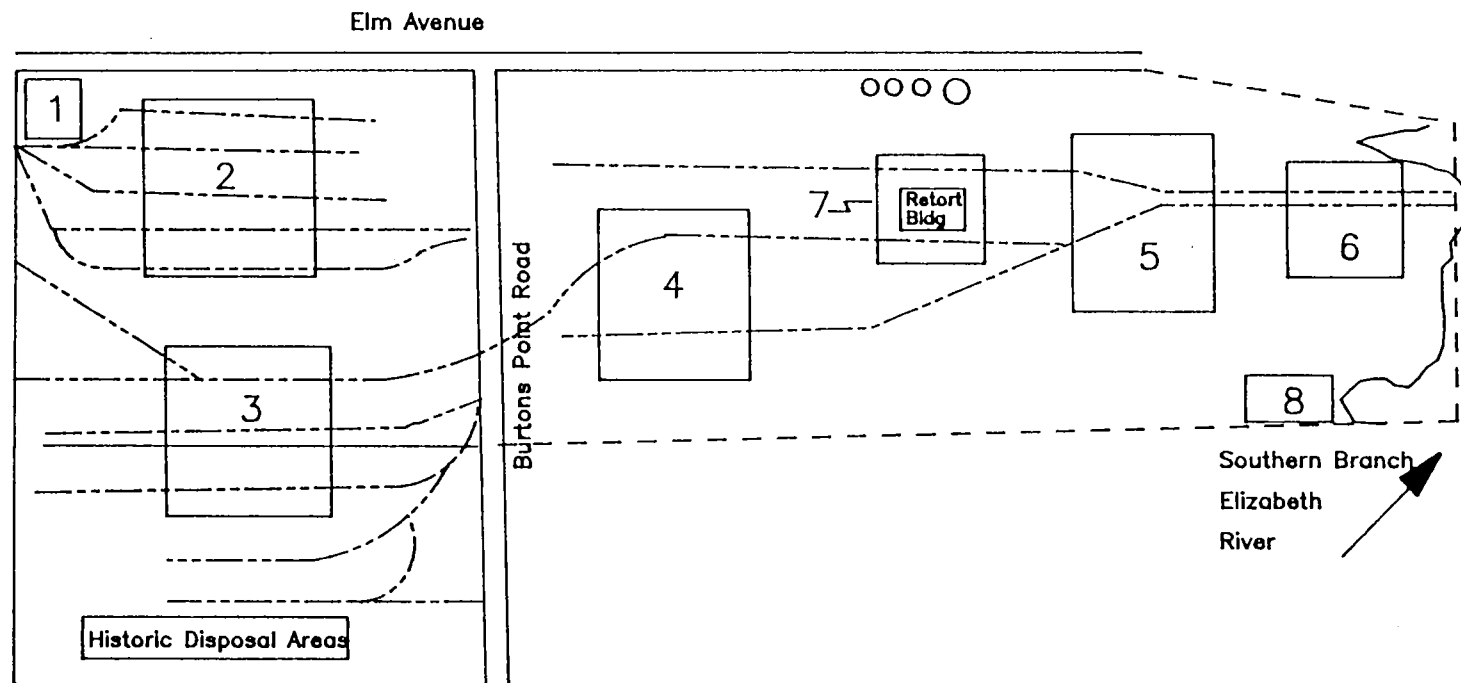
4. Determine the horizontal and vertical extent of contamination in active wood processing areas near the retort building and in soil near all treated wood storage areas.
5. Determine the vertical and horizontal extent of contamination near the former concrete oil/water separator basin.

In addition, on-site drainage features receiving runoff from areas of contaminated soil on site, such as ditches and sediment traps, should be sampled once the contaminated soil areas have been delineated. Also, in addition to the areas described above, soil samples should be collected at random to minimize site characterization bias.

ESC proposes to collect additional soil samples from other areas on site, including:

1. the historic disposal area
2. the trash disposal area
3. the material near outfall 001
4. the process area
5. miscellaneous treated wood storage areas.

ESC has some limited information about historic disposal areas which will be useful in selecting sample locations to characterize the waste and soils in these areas. The general location of the historic disposal area is depicted in Figure 14. AWI employees indicated to ESC that the historic disposal areas may have been operated in three separate locations. The westernmost area is thought to contain creosote tank bottoms and



- 1 Trash disposal area
 - 2-6 Treated wood storage areas
 - 7 Process area
 - 8 Material pile
 - Railroad tracks (only some shown)
- (scale approximate)



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Figure 14
 Proposed sample location grids
 1-8 and historic disposal areas

creo-penta tank bottoms. The middle cell is thought to contain creosote related materials. The easternmost area, which was supposedly the largest area, is thought to contain PCP related products and untreated wood. Treated and untreated wood scraps and steel bands were placed in each of the cells.

ESC will attempt to locate these three discrete areas using aerial photographs or information from former and present AWI employees. As a first step in characterizing the historic disposal areas, nine boring locations, three in each of the three areas, will be selected at random using a grid with 50-foot nodes. Continuous samples will be collected in all the borings from the ground surface to the Yorktown Confining Bed. During collection, the samples will be scanned visually and with a photoionization detector (PID). In instances when field observations and PID measurements indicate a sample may contain contamination, that sample and samples from uncontaminated areas above and below it in the same boring will be submitted for laboratory analysis. A minimum of 10 samples will be submitted for laboratory analysis. The majority of samples will be analyzed for the abbreviated TCL summarized in Table 7. However, a sample from each of three borings deemed by the field personnel as exhibiting the greatest contamination will be analyzed for the complete TCL.

The trash disposal area, process area, material pile, and treated wood storage areas will be sampled using manually operated sampling equipment and power equipment. Samples from these areas will be collected from 0-6 and 12-18 inches below the

Table 7
Abbreviated Target Compound List (TCL) and
Analytical Methods

<u>Parameter</u>	<u>Method</u>
TCL Semivolatiles	CLP
TCL Volatiles	CLP
Total Chromium ¹	CLP
Total Copper ¹	CLP
Total Arsenic ¹	CLP
Total Zinc	CLP
TPH ²	418.1
TOC ²	505
TOX ²	Dohrman Manual DX20
Total Phenol ²	IR-420.2

-
- 1/ For areas 2, 3, and 8 and groundwater samples only
2/ Indicator parameters

surface, using an auger, scoop or soil thief. Samples from the subsurface will be collected using a truck-mounted drilling rig. Sample locations will be selected at random using a grid. The shape, extent, and nodes of the grid in each area will depend on visual field observations of the occurrence of contaminated soil. At this time, the generalized grids proposed (1 through 8) have been depicted on Figure 14.

ESC proposes to collect soil samples from a minimum of 10 locations in each of the 8 grid areas. At 5 of the 10 sample locations within each grid, samples will be collected at 0-6 and 12-18 inches below land surface using manually operated equipment. At five other locations in a grid, continuous split spoon samples will be collected and described in a boring from the surface to the subsurface Yorktown Confining Bed. The deep borings will be located in the portion of each grid area with the most obviously contaminated soil. The deep borings will represent the inferred worst case scenario of soil contamination and will serve to evaluate the downward migration of contamination in each grid. During collection, the samples will be scanned visually and with a PID. In instances when field observations and PID measurements indicate a sample from the borings may contain contamination, that sample and samples from uncontaminated areas above and below it in the same boring will be submitted for laboratory analysis.

A minimum of 10 samples will be submitted for laboratory analysis. Where visual observation and PID screening indicate less than 10 contaminated samples, the remainder will be selected

at random. The samples requiring laboratory analysis from the deep borings and the surficial soils will be analyzed for the constituents listed in Table 7. One of every 10 samples, the one that appears most contaminated, will be analyzed for the complete TCL.

The justification for the selection of 10 sample locations in each grid is derived from the Permit Guidance Manual on Unsaturated Zone Monitoring for Hazardous Waste Land Treatment Units (EPA 530-SW-84-016). Table 3-2 in the referenced document summarizes recommendations for the number of cores to characterize background and active land treatment areas. In general, eight is the maximum number of cores recommended for the grid sizes to be employed at AWI. ESC intends to be conservative by collecting samples from a minimum of 10 locations in each grid. Since continuous split spoon samples will also be collected from the deep borings, from 20 to 40 samples will be collected from each grid.

Based on the analyses of the soil, fill and subsurface formation samples, additional soil, fill and subsurface formation samples may be collected at other locations.

2.B.3.2 Groundwater and the Hydraulic Characteristics of the Aquifers

One of the basic elements for defining the hydraulic characteristics of the Columbia Aquifer is a water table map. Numerous monitoring wells constructed in connection with the investigation made by Russnow-Kane & Associates, Inc. (Figure 8), were installed primarily for making water-level

measurements. In constructing these wells, bentonite seals were placed in the annular spaces just above the screened sections, but the casings were not grouted. The absence of grout behind the casings precludes their use for obtaining reliable water samples, but they may still be useful as water-level monitoring wells. These wells will be examined and tested to determine which ones can be used for this purpose. The wells found to be plugged or in which the casings have been ruptured will be abandoned to prevent the entry of surficial contaminants. Where possible, monitoring wells will be abandoned by knocking out the bottom plug, filling the casing with a cement-bentonite grout, pulling the casing before the grout sets, and introducing additional grout to fill the resulting hole to ground surface.

If it is ultimately found that the array of water-level monitoring wells is inadequate to define the precise configuration of the water table, it may be necessary to install additional monitoring wells, as depicted on the topographic map included as Appendix A.

Five monitoring wells will be drilled along the south boundary of the eastern segment of the site. These wells will be used primarily to determine water quality in the Columbia Aquifer as it enters the site from the south annex of the Norfolk Naval Shipyard. Similarly, three wells will be drilled along the western site boundary to determine the quality of groundwater entering the site from the Virginia Electric Power Company right-of-way.

Six monitoring wells will be drilled along the north boundary of the site, primarily to determine the quality of water in the Columbia Aquifer before it reaches the storm sewer along Elm Avenue or otherwise discharges across the northern site boundary.

When the limits of the trash disposal area in the northwest corner of the site are defined more precisely (from sample boring results, interviews with AWI personnel, and review of aerial photographs), and the water table configuration is defined, two monitoring wells will be drilled downgradient from this area to sample water from the Columbia Aquifer. These samples will be used to determine whether water in this aquifer may have been affected by former waste management practices in the area.

Six monitoring wells will be drilled near the large historic disposal area in the southern part of the western segment of the site to determine the effect of the area on water quality in the Columbia Aquifer.

One monitoring well will be drilled on the western site boundary, upgradient from any suspected groundwater contamination, primarily to compare the potentiometric elevation of the Yorktown-Eastover Aquifer with the water table elevation. Another such well will be drilled for the same primary purpose at the east end of the site, remote from any known areas of waste disposal. Further investigation will be made of the potential for contaminants to move from the Columbia Aquifer to the Yorktown-Eastover Aquifer, due to the head in the confined

aquifer being lowered by pumping. Wells installed into the Yorktown-Eastover Aquifer will be double cased to prevent infiltration of contamination from the overlying Columbia Aquifer. An inventory of wells in the lower aquifer and of their rates of pumping will be made. Data from this inventory will be analyzed, together with other hydraulic data and developmental trends.

The 24 additional monitoring wells are considered sufficient to delineate the extent of contamination and determine the groundwater flow direction. Several of the existing wells will continue to be utilized for collecting groundwater elevation data. Valuable information from the investigations to date aided in selecting the well locations by providing insight to existing contamination sources. These existing data will supplement chemical data collected in the future from the additional wells. The final data pool should be adequate to serve as a basis for the forthcoming FS.

The potential for contaminant migration cannot be defined without estimating the rate of groundwater movement, which requires an evaluation of the hydraulic conductivity of the Columbia Aquifer. Field tests in selected wells will be used to calculate this hydraulic conductivity.

After installation, each of the wells will be surveyed to determine the existence of nonaqueous phase liquids (NAPLs). Depending on the density, NAPLs will either sink or float in the saturated aquifer. If the well survey indicates the presence of NAPLs, appropriate measures will be taken to assess the thickness of the NAPL layer and to collect representative samples of both the NAPL and the groundwater.

The wells installed in the Columbia Aquifer will be lined with a screen extending from the top of the water table surface to the bottom of the aquifer (20 ft below the ground surface). Because the aquifer thickness is less than 20 ft, a single well will suffice at each specified location in the Columbia Aquifer. Monitoring wells installed in the Yorktown-Eastover Aquifer will have 5 to 10-ft screened intervals. Purging of the wells by pumping or bailing before sampling, for the purpose of obtaining a representative sample from the aquifer, will necessarily disturb the layer of floating product in them. Therefore, it may be necessary to purge the wells and wait approximately 24 hours to allow any floating layer of contaminants to reconstitute before a sample is collected. If there is a significant, easily measurable thickness of floating product on the water, a skimming technique may be more suitable for sampling.

The dissolved contaminants probably will have to be sampled at the same level as the more permeable, sandy layers, using a modified Kemmerer Sampler. This type of device will probably also have to be used to sample possible heavy creosote phase at the bottom of the well.

All groundwater samples will initially be analyzed for the following TCL constituents (Table 7):

- Volatile organic compounds (VOCs)
- Acid and base-neutral extractable compounds
- Total organic carbon (TOC)
- Total petroleum hydrocarbons (TPH)
- Phenols
- Total organic halogens (TOX)
- Arsenic
- Chromium

Copper
Zinc

Depending on results of the soil analyses in Phase I Removal Plan, the analytical protocol may include analyses for furan and dioxin homologs.

2.C River/Inlet Sample Plan

Article VIII.C.1 of the ACO requires AWI to include in the RI/FS Work Plan a plan for sampling the inlet receiving the stormwater discharge from NPDES Outfall 002 and other selected locations in the South Branch of the Elizabeth River. The sampling plan includes the inlet and associated portions of the Elizabeth River receiving the discharge from NPDES Outfall 002. The sampling plan is based specifically on recommendations for sampling the inlet receiving discharge from NPDES Outfall 002 made to James Miller (EPA Enforcement Project Officer, Hazardous Waste Enforcement Branch) by the EPA Bioassessment Task Group in a memo dated November 18, 1986 (Appendix I).

Before the river/inlet sampling plan is implemented, AWI will require additional clarification from the Bioassessment Task Group. Of particular concern is the analytical methodology to be employed and the reference to sample archiving. AWI requires guidance on the criteria that will trigger the analyses of archived samples. This will prevent sample holding times from being exceeded and should thus minimize the need to collect additional deep sediment samples.

The river/inlet sampling plan requires collecting a series of samples from NPDES Outfall 002. Fourteen surface

sediment samples will be collected in the vicinity of the outfall with a Van Veen Dredge at the appropriate locations noted in Figure 15. One Van Veen Dredge sample will be collected from each of five evenly spaced locations along a transect within the Outfall 002 inlet. The remaining nine Van Veen Dredge sample locations were selected to determine if a gradient of creosote-associated (PAH) contamination exists from the inlets to the river. The exact location of these nine samples will be based on the results of a survey of information detailing the tidal currents and river bottom topography. As requested in the memo from the Bioassessment Task Group, the Van Veen Dredge samples will be analyzed quantitatively for PCP, phenols, benzo(a)pyrene, naphthalene, phenanthrene, and total resolved PAHs.

In order to assess the vertical extent of contamination in the inlets, core samples will be collected using a marine or lacustrine coring device at the locations noted in Figure 15. Cores will be collected from the sediment surface to a depth of 4' to 10 feet. The cores will be examined visually for staining and evidence of creosote contamination; this information will be recorded, and the samples will be archived for future analysis. It is anticipated that a minimum of three depth intervals will be collected, described, and archived at each of the deep core locations.

ESC will collect at least one replicate from the Van Veen Dredge locations and one replicate from the "deep core" location at each outfall. Standard operating procedures for sample collection, splitting, preservation, packaging, labeling,

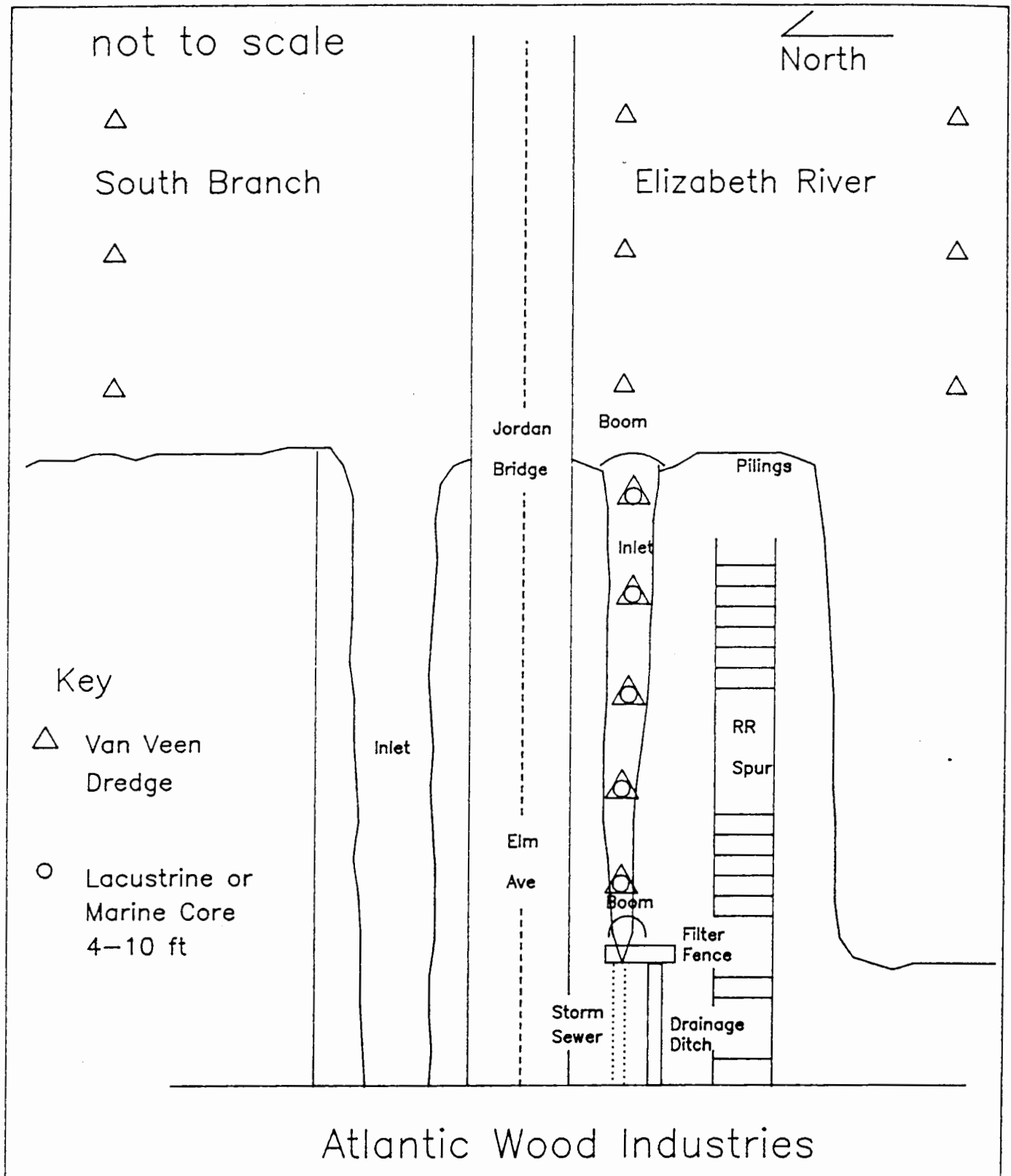


Figure 15

Suggested sampling plan
for sediment PAHs



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and chain-of-custody procedures for soil samples as specified in the companion Quality Assurance Plan will be followed. If the analytical methods deemed appropriate by the Bioassessment Task Group are not addressed in the Quality Assurance Plan, the plan will be amended.

Based on the analytical results and toxicity assessment of detected contaminants, the potential for and significance of exposure by environmental resources may be evaluated using a variety of toxicity testing techniques. Some of the techniques being considered include:

1. sediment bioassays
2. static acute bioassays
3. flow through static and chronic bioassays
4. "microtox" assays

At this time, it appears that the most likely and significant exposure pathway for environmental resources is surface water runoff, that is, the NPDES outfalls. The NPDES outfalls are also useful because AWI has already accumulated some "baseline" or preremediation environmental effects data in the form of the bioassays required by the NPDES permit. This information may provide useful perspective if the outfalls are used as bioassay stations.

2.C.1 Review of Background Information on the South Branch of the Elizabeth River

The hydrology of the Elizabeth River has been described in Section 1.A.4. As noted, there are numerous potential point and nonpoint sources of contamination in the Elizabeth River

system. The river system is located in an intensely urbanized area and is used as the receiving stream for numerous industrial and domestic outfalls. As of September 1983, there were approximately 48 industrial and 15 domestic discharges being received by the Elizabeth River.

As noted, four wood treatment related facilities have been located upstream from AWI on the Elizabeth River: Wyckoff, Eppinger and Russell, Bernuth Lembcke, and Republic Creosoting. Eppinger and Russell operated a plant on the Elizabeth River since about 1905. It treated wood using pressure and nonpressure processes and used creosote, PCP, CCA and fire retardants. At one time, the facility had at least two tanks associated with the nonpressure process and four retorts for the pressure treating of wood. The plant had a fire in 1963, was rebuilt and eventually closed in 1980.

Republic Creosoting operated a wood treating plant on the Elizabeth River since about 1933. Wood was treated using creosote in a pressure process. At one time, there were at least four treatment cylinders at the site. Republic Creosoting stopped treating wood in December 1971.

Bernuth Lembcke operates a terminal for the storage and handling of creosote on the Elizabeth River. The Bernuth Lembcke facility is still active.

There is considerable additional information available about the Elizabeth River and potential contamination sources that ESC has become aware of during the preparation of the RI/FS Work Plan. A partial bibliography has been included in Appendix

E. A review of the literature cited will continue as part of the RI/FS and is expected to provide useful information about potential off-site contamination sources.

2.C.2 Sources of Information About the Site

As noted in Section 2.B.1, the Review of Background Information, EPA has collected aqueous and sediment samples from outfall 002. AWI has also generated considerable chemical physical and biological monitoring data for outfalls 001 and 002. This information has not yet been summarized because it relates more specifically to the proposed river and inlet sampling plan. The literature review noted above will also include an analysis of the bioassay and water quality results from the NPDES discharge monitoring of AWI outfalls 001, 002 and 003.

There are no process water discharges from the AWI site. Stormwater runoff from the site, however, is regulated under an NPDES permit (permit number VA 0004189) issued to AWI by the Virginia Water Control Board. The permit regulates stormwater discharges from the three outfalls (001, 002, and 003) which have been previously described. The permit requires monitoring for flow, oil and grease, and total phenols. The permit also specifies that 48-hour static acute toxicity tests must be performed at least annually on the effluents from outfalls 001 and 002 using Mysidopsis bahia. In addition, the permit requires outfalls 001 and 002 to be monitored for the priority pollutant organics considered in EPA methods 624 and 625.

2.D Air Program

In order to put the proposed air program in perspective, this section contains an evaluation of the only existing air data related to the site, which was collected through EPA in July 1985.

2.D.1 EPA Sample Results, July 1985

The air sampling performed by EPA in July 1985 described in Section 2.B.1 involved a total of 58 samples collected from 11 sites (stations) using 4 collection techniques in 3 sampling rounds.

The EPA's subcontractor's report presents meteorological conditions from the Norfolk International Airport for July 18-19, 1985. The weather conditions presented in airport conditions and on-site in sample data sheets suggest general transport trends, but are inadequate to track air parcel movement on or off the site.

Naphthalene

EPA asserts that contaminant migration from the property off-site occurred during July 19 pm, based on a south property fence (site 11) naphthalene level of 62 ppb exceeding that of the north property boundary Elm Avenue (site 9) naphthalene level of 6 ppb. These two naphthalene values are from the only two samples collected July 19 pm. There are no July 19 pm naphthalene source emission data to support the asserted migration.

Rodney D. Turpin of the EPA advised Darius Ostrauskas of the EPA by letter on September 24, 1985 that his review of

available data led to selection of the Tenax analyses since they gave higher levels than carbon tubes and a broad spectrum analysis. Turpin's advice presents July 18 background as sites 1 and 2 with naphthalene at 5 and 6 ppb respectively; the July 19 site 6 at Burton Road with 6 ppb and site 10 at the pressure treatment building with >46 ppb. Turpin's advice does not demonstrate transport, or migration of naphthalene on or off the AWI property.

Turpin and Ostrauskas discussed the Turpin advice by telephone on September 26, 1985, and Turpin sent a new advisory to Ostrauskas on September 27 in which he repeated the original information and added the remaining available Tenax data for site 9 with 6 ppb and site 11 with 62 ppb. Site 11 sample was analyzed by another laboratory than that for site 9. This change in advice to Ostrauskas supported the view that two on-property sources (northeast drainage trench and pressure treatment tanks) probably contribute to off-site contaminant migration at the south property fence (site 11).

Naphthalene data collected by Risk Science International (RSI) on carbon, show on-site sources at the northeast stormwater discharge trench (site 3), storage pit (site 4), and the working pressure treatment tanks (site 5). The wood storage pile (site 7) may represent an additional source, or may be elevated due to contaminant migration. RSI data do not demonstrate off-property contaminant transport or migration.

2.D.2 Analysis of Results

The air sampling program instituted by EPA at the AWI Portsmouth, Virginia site used four sampling protocols for 11 sites and 3 sampling times (rounds) during the 2 day (July 18-19, 1985) period. Data comparisons and interpretation of findings are complicated by sampling protocols, use of different chemical analytical procedures, as well as varying weather conditions affecting air transport during the study.

Conclusions drawn are also a function of the choice of chemical indicators intended to represent the wood preserving process used at the AWI Portsmouth, Virginia site, as well as the collection and analytical systems for their identification. The compounds reported as indicators, benzene, toluene, ethyl benzene, and xylene, occur at different levels at the same site and their concentrations vary as much as 1,000-fold depending on the analytical methods. The aromatic indicators listed generally exhibit the lowest levels when collected on Tenax and measured by GC/MS, higher levels (as much as 10-fold) when collected on carbon and measured by GC/MS, and still higher levels (as much as 1,000-fold) when collected in Tedlar bags and measured by GC/UV.

Naphthalene was selected by EPA as an indicator of choice to represent an air contaminant of AWI's wood preservation operations despite having a lower toxicity rating than the anthracene used for EPA's air quality scoring. EPA has identified two on-site naphthalene emission sources: the northeast drainage ditch (site 3) and the pressure treatment building (site 10).

There is reasonable agreement between naphthalene measurements made by EPA and RSI for site 3, but RSI measurements for site 5 (adjacent to site 10) are five-fold higher than the related EPA sample.

EPA asserts that naphthalene levels at the south boundary fence (site 11) are sufficiently elevated above those of Elm Avenue (site 9) to demonstrate off-site migration. This assertion is based on a single set of determinations of the only two samples collected for naphthalene determinations, each of which was analyzed from a single sampling tube in a different laboratory. Although double tube Tenax samples were usually taken, no data are given which show individual analyses, permitting comparisons with the single samples given for sites 9 and 11. Likewise, there are no standard blanks.

The RSI naphthalene data do not support EPA's assertion of migration off-site. Considering all EPA and RSI naphthalene data sets together with the prevalent east-northeast winds on July 19 am and pm (rounds 2 and 3), the elevated naphthalene level at the south boundary fence (site 11) appears to be an anomaly and of dubious merit since the boundary fence level is above potential migration sources at the northeast drainage ditch and pressure treatment building. There are no ambient July 19 pm (round 3) data to use in establishing a potential source for the EPA asserted determination of off-site contaminant transport.

Based on this analysis, an initial site ambient air monitoring program is not proposed. However, the following Air Investigation/Monitoring will be implemented as remedial investigation activities take place.

2.D.3 Air Investigation/Monitoring

The objectives of the air quality monitoring program are:

- To establish baseline site conditions before remedial investigative work begins, so proper safety precautions can be taken by onsite personnel
- To monitor site conditions during ground disturbance (e.g., soil borings)
- If necessary, to assess potential offsite migration of volatile and particulate emissions. Implementation of this program will be a function of activity-monitoring results

To accomplish the stated goals, a two-phase monitoring program is planned.

- Phase I: Following establishment of appropriate baseline conditions, onsite real-time monitoring equipment (HNU, OVA) will be used during field activities
- Phase II: If, during ground disturbance operations, HNU readings are persistently >5 ppm above background levels, readings will be taken at the study area boundary at points to be selected in the field. If HNU readings continue to be >5 ppm above background, the Contingency Plan will be instituted to assess hazardous air constituents

Safety specialists and other authorized field personnel will obtain HNU or OVA measurements throughout the site and adjacent areas prior to and during surface disturbance and sampling efforts to establish study area background concentration levels. All real-time data will be recorded on air monitoring data sheets.

An indication of organic levels >5 ppm above background will be reported directly to the onsite safety officer and the site manager so they can determine safety equipment requirements. If HNU results remain >5 ppm above background, all work

will stop in that area and the area will be cleared until the source is determined. Appropriate respiratory protection will be implemented.

During onsite operations, if HNu readings are persistently >5 ppm above background readings after the above safety precautions have been taken, additional monitoring at the study area downwind boundary will be conducted at points to be selected in the field. If readings at the study area boundary are >5 ppm above background, the Contingency Plan will be implemented.

2.D.4 Contingency Plan

If the results of the Phase II air monitoring program show concentrations at the study area boundary consistently greater than 5 ppm above background, a program to assess levels of organics in the air will be conducted. The air monitoring will be conducted using monitoring stations that are to be established around the working area perimeter. One station will be upwind of the working area, and the remaining evenly spaced stations will be downwind. Actual locations will be based on wind direction rose diagram information. One personnel pump will be set up at each station. These pumps will be set up on tripods or other supports so that the intake is at least 1 meter above ground. The sampler will be protected from precipitation by a shelter (i.e., umbrella). Each pump will be monitoring VOCs and other selected organics using a Tenax tube system. Samples will be collected for analysis for an 8-hour period, once per day, for 3 consecutive days. This will provide 8-hour time-weighted average concentration data.

The procedures to be followed when collecting samples using sorbent tubes will be specified in detail before implementation.

3.0

PROJECT SCHEDULE FOR SITE INVESTIGATION PHASE OF THE RI/FS WORK PLAN

Task 1

- A. Review of aerial photographs to identify and locate potential on-site and off-site contamination sources.
- B. Review of local newspaper articles, literature pertaining to environmental investigations or contamination of the Elizabeth River, and continuing investigation and employee interviews concerning past operational practices at the site.

Task 2

- A. Inspect all existing monitoring wells and attempt to locate any missing wells.
- B. Abandon all damaged wells by removing well casing and grouting boreholes completely from depth to the surface.
- C. Verify the utility of the remaining wells by sounding them and ensuring they are connected to the water table aquifer.
- D. Obtain water level measurements from wells deemed adequate.

Task 3

- A. Install monitoring wells proposed in the RI/FS Work Plan upgradient and downgradient of all known contamination sources and all contamination sources either newly identified or verified in Task 1.
- B. Sample all monitoring wells on at least a tri-annual basis.
- C. Collect soil, fill, subsurface and on-site sediment samples proposed in the RI/FS.

Task 4

- A. Sample the sediment in the inlet and South Branch of the Elizabeth River.
- B. Based on analytical results and the toxicity of site specific contaminants (as established in the literature), determine the necessity of performing sediment bioassays using river and inlet sediment.
- C. Perform such work, if necessary.

Task 5

- A. Evaluate groundwater monitoring data. Determine if additional monitoring wells are necessary to delineate the rate and extent of contaminant migration from all contamination sources.

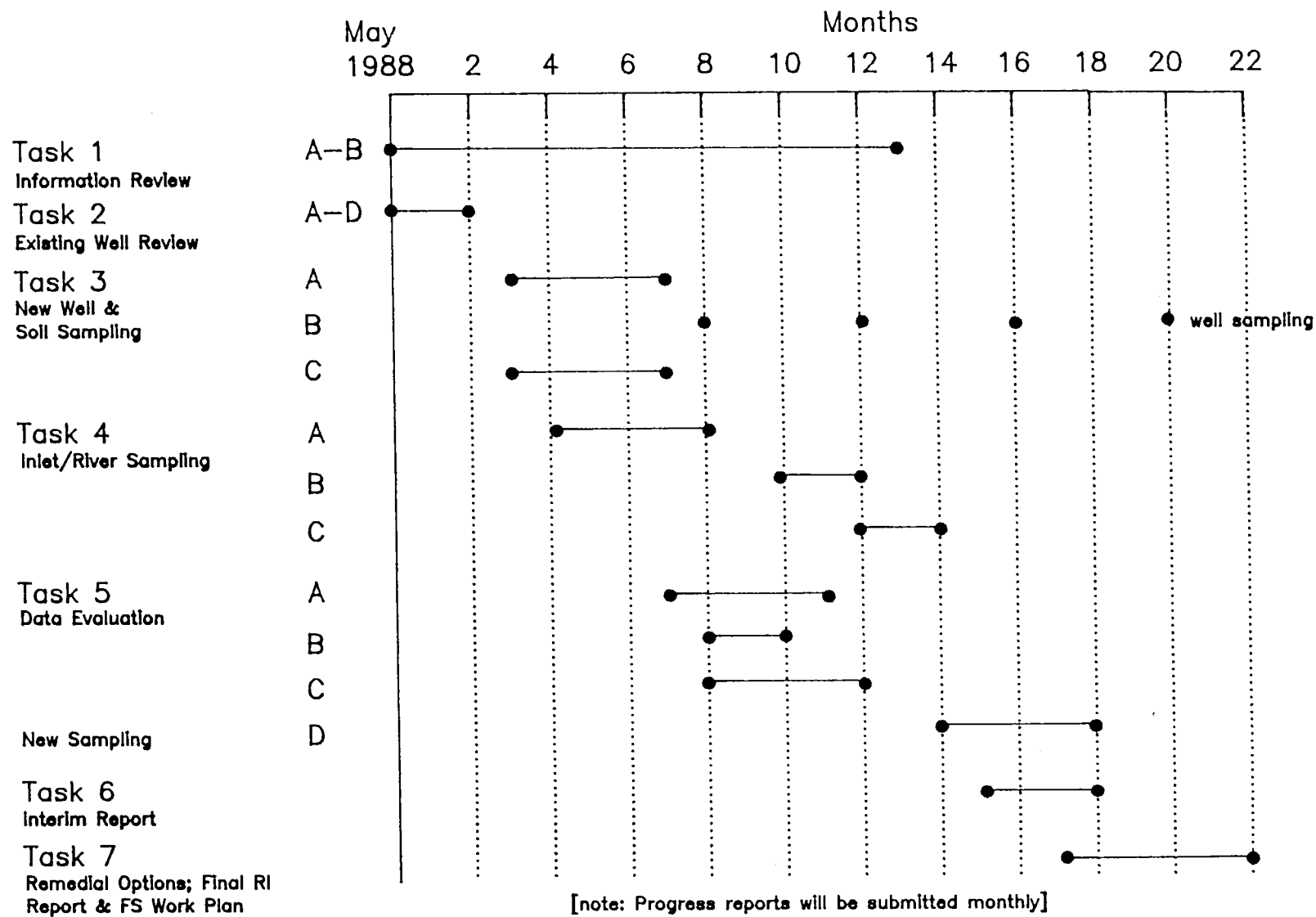
- B. Evaluate soil, fill, and subsurface samples to determine the effectiveness of subsurface layers in the attenuation of contaminants.
- C. Evaluate the analytical results from soil, fill and subsurface samples to determine the necessity of collecting additional samples in order to locate the horizontal and vertical boundaries between potentially "clean" and "contaminated" areas.
- D. Collect such subsurface samples as necessary and install additional groundwater monitoring wells as required.

Task 6

- A. Prepare interim report outlining evaluation of results to date and proposing activities under Tasks 4D, 5C, and 5D.

Task 7

- A. Conceive remedial options based on evaluation of original sampling results and data generation from Tasks 4D, 5C, and Task 5D. Prepare remedial investigation report (including Endangerment Assessment).



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Figure 16
Project Schedule
Site Investigation Phase

4.0 DATA REDUCTION, VALIDATION, AND REPORTING

The data produced for the RI/FS Work Plan will be reviewed on the technical and editorial levels. The technical level of review will concern itself with the employed sampling and analytical techniques and their effects on data validity. The editorial level of review will address the problem of transpositional errors and will ensure that the text is concise and lucid. ESC will use CompuChem Laboratories in Research Triangle Park, North Carolina, for all analytical work, CompuChem is a CLP Laboratory. The potential analyses and analytical methodologies have been summarized in Table 13. A QA/QC Plan for this RI/FS Work Plan, which was submitted to EPA as a Companion document to the Phase I Removal Plan, is also included with this Work Plan submission.

As part of the technical level of review, ESC will validate all data analyses in accordance with the "Functional Guidelines for Data Review" for CLP methods or in accordance with the QA/QC data validation criteria set forth for non-CLP methods. Once validation is complete, all data will be tabulated on a computer.

ESC will also perform at least one field audit to verify that samplers are correctly following the sampling procedures described in the QA/QC Plan. The Field Audit procedures are also described in the QA/QC Plan. A report of the field audit will be sent to the EPA Project Coordinator within 15 days of completion. ESC will notify EPA of any serious deficiencies within 24 hours of discovery.

5.0 ENDANGERMENT ASSESSMENT

5.A Introduction

As part of the Remedial Investigation, an assessment will be made of the risks to public health and the environment posed by current site conditions. The area within which endangerment is to be addressed will be determined by Remedial Investigation activities. The potential health risks associated with the study area are based on possible exposure of the public to contamination migrating offsite either through direct exposure via air or water, or through bioconcentration via the food chain. No imminent threat to human health or the environment has been established by sampling conducted to date. Any potential risks presented by future site usage will be discussed in the endangerment assessment of the remedial investigation.

The principal risk associated with the study area is the possibility of long-term contaminant migration. The offsite migration of contaminants to the South Branch of the Elizabeth River, via groundwater and surface water, could present a potential risk to aquatic organisms in the river. Although no direct human health threat has been identified with this pathway, risk to biological receptors and the potential for resultant bioaccumulations in the food chain will be examined.

The risk to potentially exposed organisms will be determined based on an evaluation of the pathways of exposure and other factors. These exposures will be addressed in terms of the potential dose to the exposed population. Based on consideration

of the potential doses, the nature of the exposed population, and the toxicity of the chemical of concern, an assessment of the health risks posed by a given level of residual contamination will be made. The various alternative remedial action plans can then be evaluated in terms of the health risk. Adverse environmental impacts will be thoroughly investigated and evaluated.

The following factors will be considered:

1. Potential adverse effects on groundwater quality considering:
 - a. The physical and chemical characteristics of the waste, including its potential for migration
 - b. The hydrogeological characteristics of the facility and surrounding land
 - c. The quantity of groundwater and the direction of groundwater flow
 - d. The proximity and withdrawal rates of groundwater users
 - e. The current and future uses of groundwater in the area
 - f. The existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality
 - g. The potential for health risks caused by human exposure to waste constituents
 - h. The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents
 - i. The persistence and permanence of the potential adverse effects
2. Potential adverse effects on hydraulically connected surface water quality, considering:
 - a. The volume and physical and chemical characteristics of the waste

- b. The hydrogeological characteristics of the facility and surrounding land
- c. The quantity and quality of groundwater, and the direction of groundwater flow
- d. The patterns of rainfall in the region
- e. The proximity of the source to surface waters
- f. The current and future uses of surface waters in the area and any water quality standards established for those surface waters
- g. The potential for health risks caused by human exposure to waste constituents
- h. The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents
- i. The persistence and permanence of the potential adverse effects

5.B Information Requirements

After the data have been collected, this information must be organized to allow for the following: an assessment of the type and potential hazard of the waste; an assessment of the mechanisms and rates by which hazardous constituents may migrate offsite; an identification of receptors that may be affected by those constituents; and a determination of the severity of the potential effects. The following discussion describes considerations within these categories.

1. Waste characteristics - The waste characteristics category contains considerations that examine the waste's environmental mobility and persistence, and the adverse affects it can cause. These considerations are:

- Toxicity
- Persistence
- Ignitability
- Reactivity
- Corrosivity
- Solubility
- Volatility
- Physical state

Solubility, volatility, and physical state measure the extent to which mobile wastes can leave the study area. Toxicity and persistence assess the study area's potential to cause health-related injuries. Ignitability, reactivity, and corrosivity evaluate the possibility of fire, explosion, or similar emergencies.

2. Site Characteristics - The site characteristics category considers the physical conditions of the site that may contribute to the potential for offsite migration. These considerations are:

- Climate
- Past site uses
- Existing site uses
- Drainage characteristics
- Surficial soil characteristics
- Slope
- Vegetation patterns
- Ecological system
- Waste containment

These data are useful in assessing the potential for contaminants to exit the site via available pathways.

3. Pathways - This category considers the potential for migration and attenuation of contaminants. The items considered are:

- Levels of contamination
- Type(s) of contamination
- Distance to nearest surface water body
- Depth to groundwater and vertical permeability
- Net precipitation
- Groundwater flow rate
- Food chain
- Air quality

Distance to the nearest surface water and depth to groundwater measure the availability of pollutant migration routes. Soil permeability, mineralogy, thickness, etc., measure the potential for contaminant attenuation and ease of migration. Net precipitation uses, annual precipitation and evapotranspiration to estimate the amounts of leachate a site produces. Evidence of contamination, type of contamination, and level of contamination evaluate pollution currently apparent at the site.

4. Receptors - This category considers the proximity of human populations and critical environments, the types of water uses within the area, and the potential for future growth. The considerations in this category are:

- Population within reasonable proximity of site
- Distance and direction to drinking water wells
- Distance to offsite buildings
- Land uses
- Critical environments

Residential populations and distance to the nearest offsite building measure the potential for human exposure. Distance to the nearest drinking water well measures the potential for human ingestion of contaminants should underlying aquifers be polluted. Land use

evaluates the current and anticipated uses of the surrounding area. The critical environment determines the potential for adversely affecting important biological resources and fragile natural settings.

Soils, surface water, groundwater, air, biota, and demographic information to be used in the Endangerment Assessment will be obtained in the Site Investigation Sampling Plan described in Section 2.B. A principal objective of the investigation is to obtain sufficient primary data on which the Endangerment Assessment will be based. Throughout the field (and laboratory) investigation, the data for each environmental medium will be reviewed to determine whether suitable and sufficient data have been collected to allow a thorough endangerment assessment.

5.C Risk Assessment Procedures

After organization of the site data into manageable environmental categories, a determination of the potential environmental risks associated with the site will be made. This involves the application of certain techniques to estimate the leachate generation rate, the ability of the groundwater and surface water to conduct contaminants, the potential for exposure of humans or environmental resources to the contaminants, and potential impacts of exposure on humans and other environmental receptors.

The hazard potential of the waste source is determined by the toxicity associated with the chemicals and the potential

for leachate generation and migration. The toxicity associated with the contaminants will be assessed by sampling and comparing the results to certain water quality and health criteria, including:

1. RCRA standards for hazardous waste facilities
2. Clean Water Act priority pollutant standards
3. Safe Drinking Water Act standards
4. Applicable literature on toxicology and public health data for specific chemicals
5. Short and long-term toxicity data and bioaccumulation data
6. OSHA standards for concentrations of pollutants in the workplace
7. Multimedia environmental goals (MEGs) as defined by the EPA for short-term exposure of human populations or biota
8. Health Advisories - EPA guidelines on anticipated impact of some synthetic organic compounds
9. State of Virginia Water Quality Standards
10. U.S. EPA Ambient Water Quality Criteria (EPA 440/5-86-001)

Migration potential is determined by evaluating any containment structures and the degree of contact between the waste sources and the migration pathway. Containment structures would prevent migration and therefore decrease environmental risks. Leachate generation can be estimated through the use of a water balance, which compares precipitation, runoff, and evaporation to determine infiltration. By estimating leachate generation, the amount of contaminants that have entered or are entering the aquifer can be estimated.

The quantitative carcinogenic risks of known or probable human carcinogens detected at the site will be assessed. The carcinogenic risks to potentially exposed personnel will be estimated before initiating any remedial activities at the site.

Potential risks to environmental receptors, in addition to human exposure, will be included in the Endangerment Assessment. As discussed, toxicity data from the literature will be reviewed and compared to the RI analytical results. Based on this comparison, a determination will be made of the necessity of implementing toxicity testing in addition to that currently required by the NPDES permit. The types of toxicity testing techniques under consideration and possible toxicity testing locations are outlined in Section 2.C. The results of any toxicity testing deemed necessary are relevant to the Endangerment Assessment and will be incorporated into the evaluation of potential environmental risks.

6.0 REMEDIAL INVESTIGATION REPORT

6.A Progress Reports

Monthly reports will be prepared to describe the technical progress of the project. These reports will discuss the following items:

1. Identification of site and activity
2. Status of work at the site and progress to date
3. Percentage of completion and schedule status
4. Difficulties encountered during the reporting period
5. Actions being taken to rectify problems
6. Activities planned for the next month
7. Changes in personnel
8. Major decisions and supporting rationale

The monthly progress report will list target and actual completion dates for each element of activity, including project completion, and will provide an explanation of any deviation from the milestones in the work plan.

6.B Remedial Investigation Reports

A draft Remedial Investigation Report and final Remedial Investigation Report will be prepared at the end of the Remedial Investigation. The reports will summarize the methods, findings, and conclusions of the RI, as well as the objectives of the Feasibility Study. The following is an outline of the format of these reports:

Executive Summary

1.0 Introduction

Site and Project Background
Assessment of Environmental Conditions
Objectives

2.0 Environmental Setting

3.0 Hydrogeological Investigation and Review of Phase I RI/FS Initial Response Action

4.0 Surface Water Investigation

5.0 Soils Investigation

6.0 Biological Investigation

7.0 Air Investigation

8.0 Waste Characterization

9.0 Bench and Pilot Studies

10.0 Endangerment Assessment*

Potential Receptors
Health Impacts
Environmental Impacts

11.0 Summary of Findings

Conclusion
Recommendation for FS
Recommendations for additional studies
References
Appendices

* This item will be prepared as a separate report,
which will be summarized within the RI Report.

NOTE: A feasibility Study (FS) Work Plan will be
developed along with the final RI Report.

7.0 FEASIBILITY STUDY

7.A Purpose

The purpose of the Feasibility Study (FS) is to develop, evaluate, and select remediation approaches for existing or potential future impacts resulting from past or present waste management activities. The Remedial Investigation (RI) will serve as the basis for the FS. The original sampling results are not valid for drawing conclusions about preliminary remedial measures. However, preliminary remedial technologies are listed under Task 2 of this section. The FS will serve as preliminary engineering study to evaluate and select the remedial alternatives for individual sites as well as for the study area as a whole.

7.B Scope

The FS will consist of seven tasks:

- Task 1 - Description of the Proposed Responses
- Task 2 - Preliminary Remedial Technologies
- Task 3 - Development of Alternatives
- Task 4 - Initial Screening of Alternatives
- Task 5 - Evaluation of Alternatives
- Task 6 - Feasibility Study Report
- Task 7 - Additional Requirements

An FS Work Plan detailing the technical approach, project management, and schedule will be completed simultaneously with the RI Report.

Task 1 - Description of the Proposed Responses

Study area background information and a summary of the RI findings and conclusions will be prepared. A statement of

purpose and objectives and a detailed FS scope of work will be developed in response to the RI's findings and conclusions.

Task 2 - Preliminary Remedial Technologies

Based on the RI findings and conclusions and the statement of purpose established in Task 1, a master list of potentially feasible remediation technologies has been prepared. The master list includes both onsite and offsite technologies. Interaction between different remedial action technologies will be evaluated. The master list will then be screened to select remedial technologies suitable for the study area.

A critical aspect of the FS preparation is screening available remedial alternatives for the site. A preliminary list of remedial alternatives was compiled during preparation of this RI/FS Work Plan to ensure that the appropriate types of data are collected on which to base the screening process. For example, gathering information on the site stratigraphy is essential when assessing the utility of constructing a slurry wall, since a slurry wall must be tied into a confining bed to accomplish its intended purpose.

A preliminary list of remedial alternatives is presented in Table 8. This list will be expanded and then screened to limit the in-depth analysis of alternatives to those which may be applicable, technically feasible, and reasonably economical to the AWI site. The preliminary list in Table 8 is separated into alternatives for the remediation of soil, groundwater, and surface sediments. Air was not included in the list because

Table 8

Preliminary List of Remedial Alternatives

Soil

- Excavation and on-site disposal
- Excavation and off-site disposal
- Excavation and on-site incineration
- Excavation and off-site incineration
- Excavation and bioremediation
- In-situ bioremediation
- In-situ solidification
- Soil surface capping
- No action

Groundwater

- Groundwater pumping
 - Recovery wells - free product and groundwater
 - Well points
 - Subsurface drains
- Groundwater treatment
 - Activated carbon
 - Biological treatment
 - Air stripping
 - In-situ bioremediation or chemical treatment
 - Land treatment/spray irrigation
 - Deep well injection
 - Chemical treatment
- Groundwater controls
 - Selective aquifer drawdown
 - Slurry walls/grout curtains
 - Subsurface drains
 - Sheet piling
- Alternate water supply
 - No action
 - Monitoring
 - In-situ bioremediation
 - Land treatment/spray irrigation
 - Deep well injection

- Groundwater controls
 - Selective aquifer drawdown
 - Slurry walls
 - Grout curtains
 - Subsurface drains
 - Sheet piling
 - Surface soil capping
- Alternate water supply
- No action

long-term volatile emissions will be controlled by remediating the other media, and short-term volatile emissions will be addressed during implementation of the various work plans for site investigations and remedial activities. The Contingency Plan included in this RI/FS Work Plan and implemented in the air monitoring program indicates that volatile emissions present a health hazard at the site.

Task 3 - Development of Alternatives

Preliminary alternatives for management of specific areas within the site (including exposure rate, if necessary) will be developed on the results of the remedial investigation and consideration of the screened preliminary remedial technologies. These alternatives will take into account the remedial response objectives, including:

- Public health and environmental concerns
- Findings and conclusions of the RI Study
- Guidance and requirements of the National Contingency Plan (NCP)
- Applicable federal and state standards, guidance, and advisories

Site-specific alternative selection will include, as appropriate:

- Offsite treatment and disposal
- Alternatives that meet or exceed applicable standards or criteria
- Alternatives that do not achieve relevant standards or criteria, but will provide suitable levels of environmental protection
- No action

Preliminary clean-up objectives will be developed in consultation with EPA and the State.

Task 4 - Initial Screening of Alternatives

The alternatives developed in Task 3 will be screened to eliminate those alternatives that are infeasible or inappropriate based on six screening criteria. The criteria are:

- The long-term uncertainties associated with land disposal
- The persistence, toxicity, mobility, and propensity to bioaccumulate of hazardous substances and their constituents
- Short- and long-term potential for adverse health effects from human exposure
- Long-term maintenance costs
- The potential for future remedial action costs if the alternative remedial action were to fail
- The potential threat to human health and the environment associated with excavation, transportation, and redisposal or containment

During the course of completing this task or at any point in the Feasibility Study, should it become apparent that additional site-specific data are required to screen or evaluate alternatives (e.g., specific location foundation characteristics), that data will be obtained in the most rapid and efficient manner possible. The goal will be to obtain this information without delaying the progress of the Feasibility Study.

Bench and pilot studies may be needed to obtain sufficient data to evaluate remedial alternatives or provide information for the design and construction of a selected alternative. If bench and pilot studies are deemed necessary based on work

activities, a separate workplan and schedule will be developed for EPA approval. This work plan will be submitted early enough to maintain steady progress of the overall Feasibility Study.

Task 5 - Evaluation of Alternatives

A detailed analysis of the alternatives passing the Task 4 initial screening will be conducted. The detailed analysis will further consider, at a minimum:

- Technical considerations (feasibility, safety, etc.)
- Protection of human health and the environment
- Institutional issues
- Cost
- Regulatory requirements and guidance
- Consistency with other site-specific remediation alternatives
- Utilization of permanent solutions and alternative treatment technologies or resource recovery technologies

Upon completion of the detailed analysis of each alternative, a final comparison and evaluation of these alternatives and their component technologies will be performed.

A summary of alternatives will be prepared highlighting important differences among alternatives. The following information will be included for each alternative:

- Public health information
- Environmental effects
- Technical aspects
- Compliance with applicable technical requirements and environmental regulations
- Community effects

- Offsite disposal information
- Institutional factors
- Present worth of total costs

Task 6 - Feasibility Study Report

A Feasibility Study Report will be prepared describing the evaluation/recommendation process in detail and the results of this process.

A management plan will be presented including preliminary engineering concept of all management program components.

Task 7 - Additional Requirements

The additional tasks required to implement the management plan, such as post-closure plans, compliance schedules, and long-term monitoring, will be provided.

8.0 COMMUNITY RELATIONS PLAN

Community relations activities during remedial investigations are dictated primarily by the site-specific community relations plans (CRPs). A CRP details how the EPA will (1) inform the affected community about the site and (2) elicit community input into response decisions. A CRP will be prepared and put into action before site work begins. The EPA has completed a CRP for the site and will implement the communications activities specified in the CRP. AWI will take part in these communication activities.

Generally, CRPs specify two types of activities: (1) the provision of periodic progress reports on the findings of the remedial investigation, and (2) the solicitation and documentation of comments and concerns from citizens, local officials, and community or environmental groups. These activities are discussed below.

8.A Progress Reports

Citizens will want understandable, accurate information about the progress and findings of the remedial investigation. The CRP will specify the most appropriate methods for providing this information. The methods include:

- Informal meetings for distributing significant test results or other findings
- Meetings with individuals or groups affected by the results of health studies
- Briefings of local and State officials

- Progress reports and fact sheets
- News conferences
- A repository for site information at the local library, health office, or community center that contains approved technical documents, official phone numbers, and a copy of the CRP
- Site visits

8.B Soliciting and Documenting Community Concerns

An effective community relations program gives members of the affected community opportunities for input. Citizens should be encouraged to ask questions and suggest response actions. EPA, the State, or AWI must respond to those questions and concerns and consider them in response decisions, whenever possible. The issues raised by the community may affect subsequent investigatory actions or suggest important issues for EPA, the State, or AWI to consider in selecting an appropriate remedy for the site.

Ultimately, the EPA will prepare a Record of Decision (ROD) describing the remedy selected for the site. Superfund community relations policy requires EPA staff to prepare a responsiveness summary to be included with ROD. This responsiveness summary describes the comments and concerns raised by the community during the RI/FS process and explains how EPA addressed those concerns in selecting an appropriate remedy. If a public meeting is held following the release of the FS Report, an official transcript of the proceeding will be prepared for use in the preparation of the responsiveness summary. The activities listed in the previous section are useful techniques for encouraging community input during the remedial investigation.

8.C Coordination

Many of the institutional considerations discussed above involve coordination with other agencies or local officials. In addition, it may be necessary to coordinate with other EPA offices, Federal agencies, and States.